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Description of a Camera Illuminant Unit Employing Vertical Illumination*

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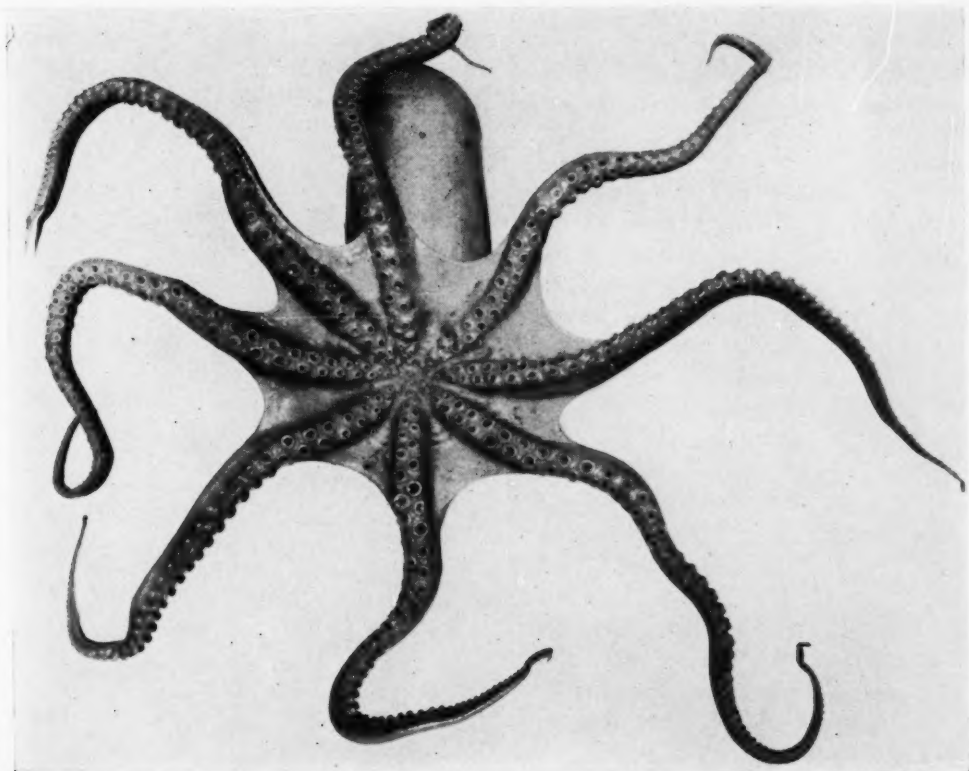
Introduction

THE problems of photographing shells ranging in size between 0.5mm and 5.0mm are mainly problems of illumination. Being opaque, transmitted light cannot be used. Having a depth equal to about half their diameter, or width, lens apertures about f/50 are necessary for overall sharpness. In order to illustrate specimens with sufficient accuracy



Octopus Specimen. Preserved on white paper. Near-Parallel light. Inwardly displaced shadows towards tentacle ends due to light beam being less divergent than image beam.

* Received for publication February 20, 1953.

Figure 1(A). Struthiolaria Specimen by Oblique Lighting.

conchologists are usually obliged to resort to drawing aided by a camera lucida or projection microscope. The work is tiring, difficult, calls for considerable draughtsmanship and is prone to errors caused by unsuitable optical conditions. It was in order to eliminate the foregoing that a series of experiments with vertical illumination were started in the Photographic Department of the Dominion Museum about two and a half years ago. These resulted in a form of apparatus being designed and constructed which permits the photographic delineation of external shell structure with great accuracy, clarity and speed. Figure 1(A) shows a typical example from the files of *Struthiolaria sp.* photographed some years ago, presumably by daylight against a grey background. Figure 1(B), *Struthiolaria, S. papulosa,* was photographed recently by vertical illumination.

Brief Outline of Vertical Illumination

Vertical Illumination (V.I.) takes place in photography, as distinct from microscopy, when the camera and illuminant are in the same optical axis. That is, when the axis of the image beam entering the camera and the light beam axis from the illuminant are superimposed. The visual effect of V.I. Fig. 1 (B) is as though the illuminant were shining through the camera on to the specimen. In microscopy this is what actually happens, the objective acts as a condenser, but with camera lenses this is not practicable since the smallness of the aperture would reduce the amount of light passing in both directions.

Under V.I. *Struthiolaria* is evenly lit, no real shadows are visible either within the shell area or upon the background and there is a minimum of light from the background reflected into the lens by the sides of the shell. The periphery of the

Figure 1(B). Struthiolaria Papulosa. A gerontic specimen photographed by V. I.

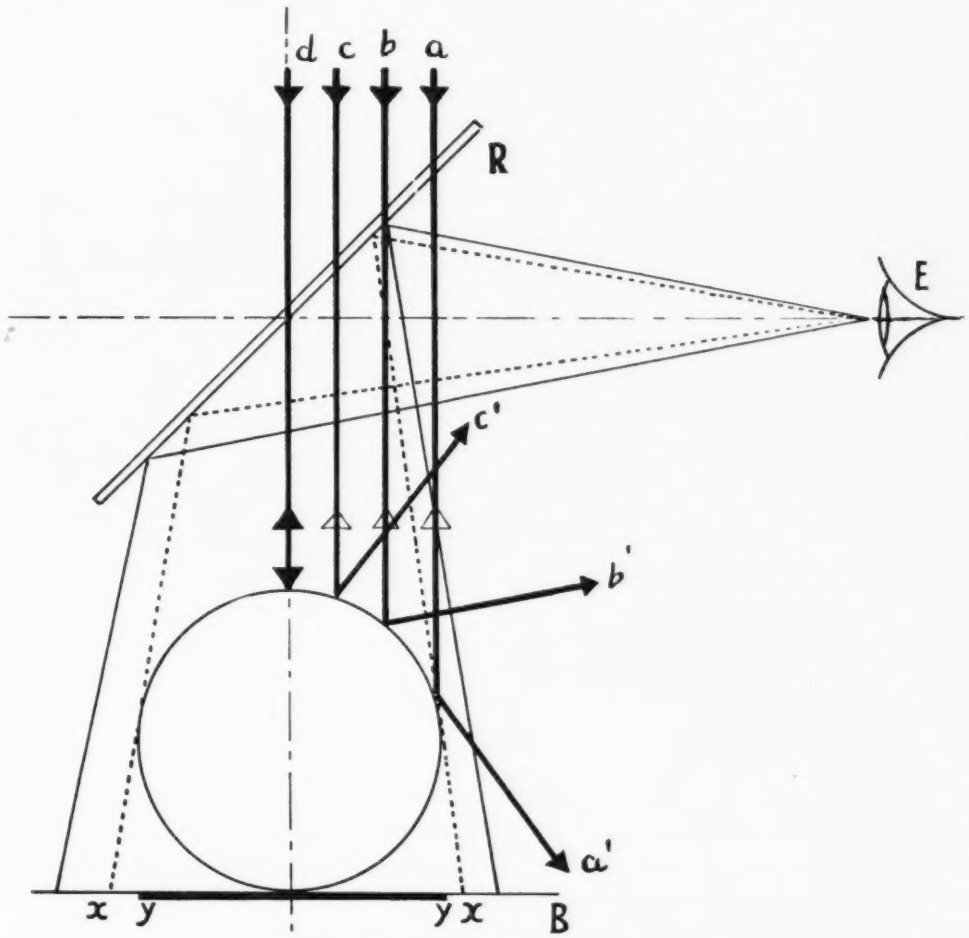


Figure 2(A). Reflection at Spherical Surfaces.

shell is considerably darker than the inner portions or the background; this dark line being especially desirable as establishing shape for purposes of identification. In addition, the sculpture of the shell is not reproduced by shadows cast by oblique light, the tone of any one point being determined by the angle it subtends to the light axis. Thus areas which are normal to the light are bright, those which are inclined to the light are dark, the principle of this V. I. *Effect* being that of reflection at spherical surfaces[1]. The sphere in Fig. 2A is illuminated by four parallel rays of light, *abcd*. The reflector R is placed as shown to view the surface from a point on the vertical axis. Ray *d*, being normal, is reflected back at maximum strength; ray *c* is reflected slightly away from the vertical towards *c'*, and rays *b* and *a* towards *b'* and *a'* respectively. With diffusely reflecting surfaces a gradual fall-off in strength of the reflected rays from *d* to *a* will be noticed, but with polished surfaces only the area around *d* will be bright — actually an image of the light source.

The shadow of the sphere cast on background B will have a diameter yy, whereas the periphery of the sphere will,

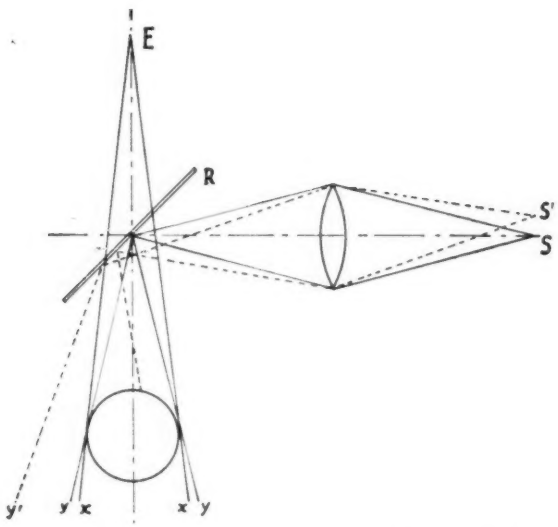


Figure 2(B). Vertical Illumination with Divergent Rays.

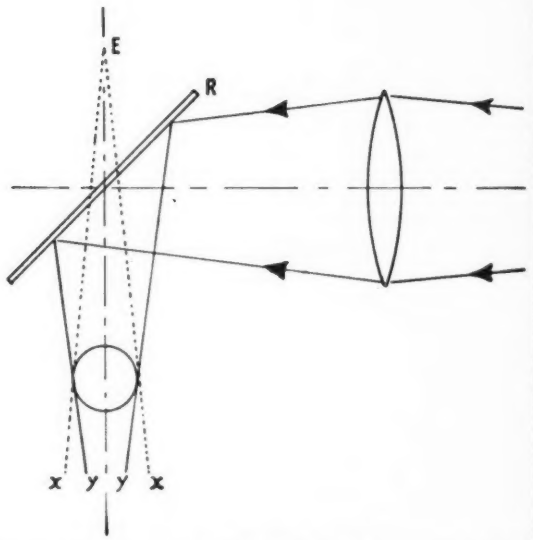


Figure 2(C). Vertical Illumination with Convergent Rays.

to the eye, appear to have a diameter as great as *xx*. As *xx* is greater than *yy*, no shadow is visible.

S.papulosa was illuminated by parallel light. To get parallel light a positive lens of large diameter is used with the light source positioned at its primary focal point. The diameter of the condensing lens determines the size of the largest specimen which may be lit with parallel light. Divergent rays cover a larger area. Slightly divergent rays may be considered parallel. Divergent rays whose angle of divergence exceeds the angle which the image beam subtends at the lens lead to results shown in Fig. 2B. Light from S is reflected by R on to a sphere which throws a shadow of diameter *yy*, while the image of the periphery is only *xx*. Hence the specimen outline is increased in thickness by the distance *xy* and is no longer a true representation. If now the condenser and light source together are moved away from the reflector and the angle of the illuminating beam is narrowed until it is less than that of the lens, the same area will be covered while the diameter of the shadow will be reduced.

With converging rays (Fig. 2C) the opposite effect is obtained and shadows are rarely apparent even with off-axis light. Convergent light is useful with specimens which show too much fall-off under parallel light, for it increases the area of surface which reflects towards the lens.

Parallel and divergent light rays incident upon a convex surface behave as in Fig 2D where *a* and *b* are parallel and divergent rays, respectively, incident upon the same point. The angles of incidence *i* and reflection *r* being equal, the reflected direction of ray *a* is *a'* and of *b* *b'*, which means that less light, from a diffusely reflecting surface, reaches the lens from *b'* than from *a'*. For points on the surface further from the vertical axis *r'* increases proportionately faster than *r*. Thus divergent light gives a steeper fall-off towards the periphery than parallel light for a given degree of diffuse surface reflection. In practice it will be found that variation

in the diffuseness of surfaces as reflectors is a more dominant factor than the angle of incident light, and as surfaces of shells can only be measured very roughly by eye in respect of their coefficients of reflection, suitable angles of incident light must be judged for each individual specimen photographically by trial and error.

Modifications to V.I. Systems Required When Using Photographic Lenses

The optical arrangement for vertical illumination as used in microscopy cannot be applied without modification to photographic lenses. As can be seen from Fig. 3A the reflector R is placed within the microscope tube just above the objective O, which performs two functions: firstly as a condenser it focusses the beam from R upon the specimen, and secondly it forms the image beam which passes up the tube to E. The microscope objective is not fitted with a variable diaphragm and works always at full aperture, whereas the photographic lens is stopped down to increase depth of field. This aperture reduction would also reduce the amount of light reaching the specimen during the first stage and during the second it would reduce the intensity of the image beam. So, all in all, only an infinitesimal amount of light would finally reach the plate.

Three types of reflectors are used in microscopy: a sheet of plane-parallel glass, as illustrated; a prism which occupies half the section of the tube, thus totally reflecting all the light from S but only permitting half the image rays from the objective to reach E; a plane silvered mirror which acts similarly to the prism. With photographic lenses only plane glass can be used. When placed outside the camera in front of the lens and inclined at an angle of about 45° it reflects

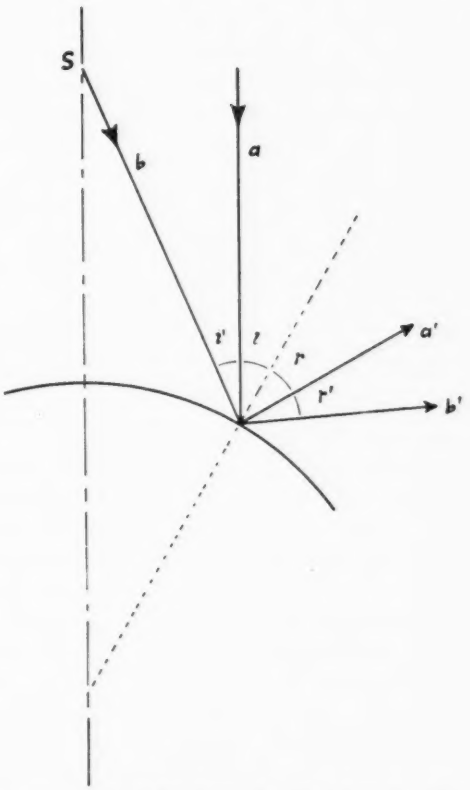


Figure 2(D). Behaviour of Parallel and Divergent Rays Compared.

about 10% of the incident light. Consequently such reflectors need ten times the normal light intensity at the source.

In the modified optical system, when used with an ordinary technical type camera focusing from the back, the illuminating unit as a whole (light source, condenser, filter and/or polariser, and reflector) is separate from the camera unit, so that at all times a maximum of light may reach the specimen. After trials with both horizontal and vertical arrangements, the latter was found to be altogether easier, quicker and more adaptable to a wider range of specimen sizes.

In the optical system of modified vertical illumination the two axes of the camera and the illuminant bear a fixed

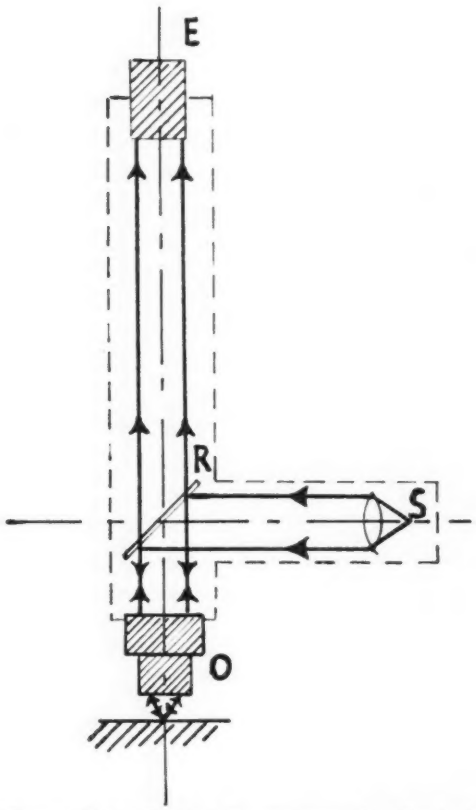


Figure 3(A). Optical Arrangement for Vertical Illumination with Microscope.

relationship, namely, they are at right angles and they intersect at a point on the first surface of the reflector. Thus a vertical movement of the lens away from the specimen must be accompanied by a corresponding movement of the entire lighting unit in the same direction and to the same degree. Accordingly, it is convenient if lens, reflector and all components on the light axis are built into one unit so that their relationship on the horizontal plane may remain constant when desired.

Focusing of the specimen is achieved by moving this unit as a whole towards or away from the specimen together with the usual movement of the focusing screen in relation to the lens. Component relationships are shown diagrammatically in Fig. 3C. Variable relationships, marked *v*, are:

Plate — lens
Specimen — light axis
Condenser — camera axis
Condenser — lamp
Lamp — camera axis

Fixed relationships:
Reflector — light axis
Reflector — camera axis.

The reflector should be rotatable, removable, adjustable vertically and horizontally. The light source should be adjustable vertically, horizontally and laterally. The support for the specimen should provide adjustments in all three dimensions and be rotatable.

The Reflector

The reflector is a sheet of plane glass, ideally an optical flat. Its thickness does not seem important since satisfactory results have been obtained through plate glass 1/4" thick. Its size is determined by the optics of the illuminating beam, a generally useful size being 10"x8". Smaller specimens are handled more easily with a reflector 2"x2", and the smallest are covered by a microscope slide.

Although referred to as a 45° reflector, the glass plate is often used at an angle modified by several degrees. Such an instance is illustrated by Fig. 3D which shows a reflector at the 45° position at R'. Parallel light from S' is reflected upon a specimen at O, indicated by dashed line. As slightly off-axis lighting is required to compensate for irregularities of the specimen, the light source is moved from S' to S^2 with the result that the incident beam is inclined upwards — in this case by 10°. The reflected beam (dotted lines) is moved back towards O by rotating the reflector 10° to R^2, but

this is not sufficient to cover the specimen completely with light. Alternative adjustments are now possible: either the reflector can be rotated beyond R^2, or it can be moved bodily to the left. In the former case the angle of the incident beam will become more oblique; in the latter it will remain the same. It will be found that adjustments need only be made above *or* below the light axis, since it is simpler to rotate the specimen 180° on the holder than make inconvenient adjustments to the components on the light axis.

An extension of the V.I. technique is the use of an ordinary silvered mirror at the edge of the image beam. The reflector is removed and the mirror placed as shown in Fig. 3E. This produces a shadow line on the side of the specimen opposite the mirror the thickness of which can be varied (a) by shifting the mirror along the light axis and thus changing the angle of incident light, or (b) by lowering the plane of the background behind the specimen which causes a displacement of the shadow, indicated by dotted lines.

High Intensity Light Sources

High intensity light sources are required owing to the great losses of light at the plane glass reflector and also because of the small lens apertures used. Tungsten lamps of the 500 watt 230 volt projector type were found to generate far too much heat for the amount of actinic light produced when this was collimated into a narrow beam. An enclosed arc like the *Pointolite* although providing exactly the right kind of light from a steady source was not satisfactory owing to low intensity and igniting difficulties. The positive crater of a D.C. arc would provide a highly actinic and steady source where direct current is

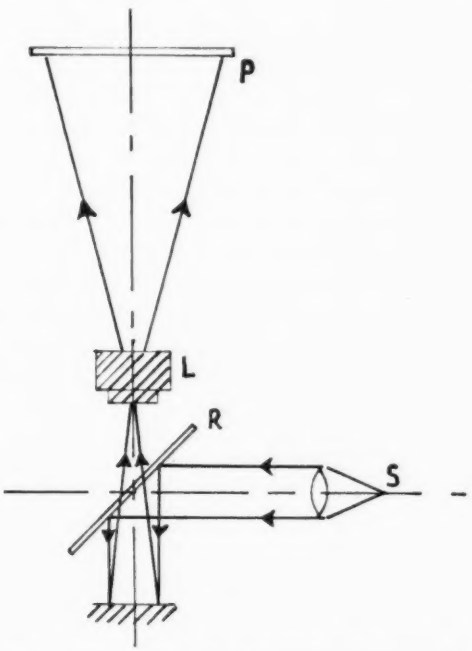


Figure 3(B). Modified Optical Arrangement for Vertical Illumination with Ordinary Photographic Lenses.

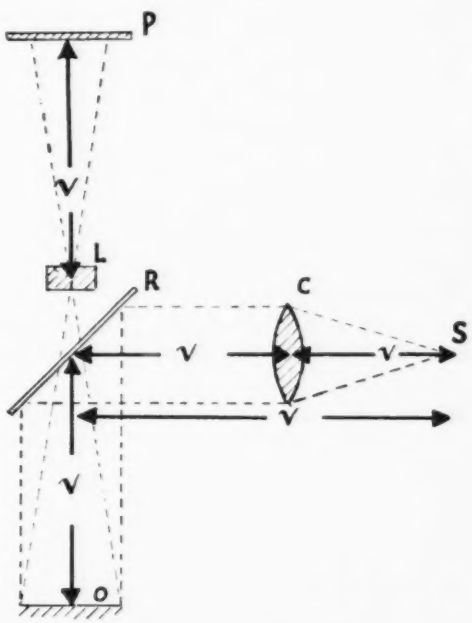


Figure 3(C). Component Relationships, Fixed and Variable.

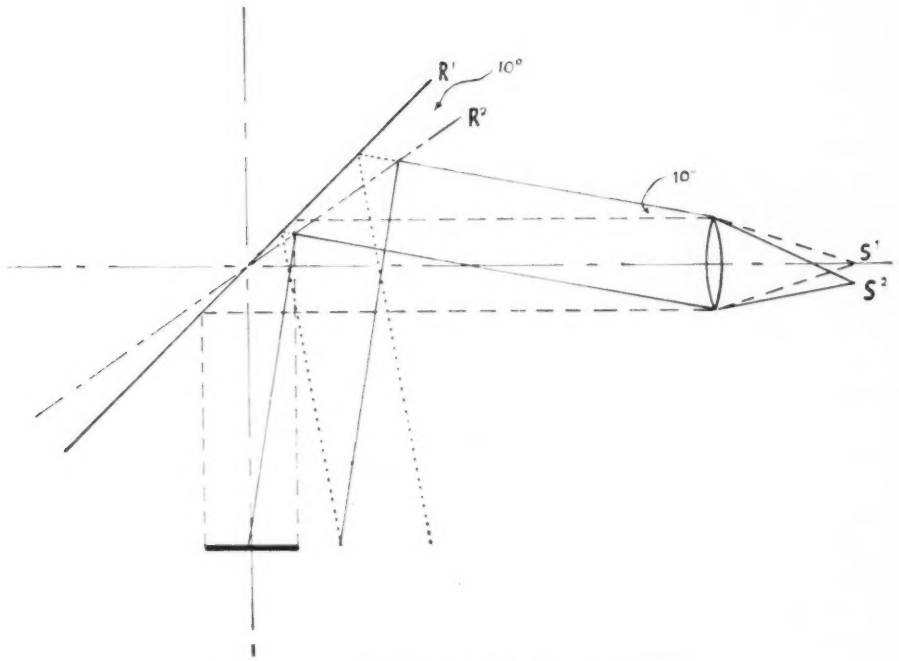


Figure 3(D). The Effect of Reflector Adjustments.

available, when working at about 20 amps. The small photomicrographic arcs of 5-10 amps sufficient for microscope work using transmitted light were found quite inadequate. As only A.C. was available a compromise was reached by using an old "scissors" type carbon holder fitted with 6mm white flame A.C. carbons. In order to cut down current consumption and steady the flame a transformer-choke was designed and installed by *The Transformer Co. of N.Z., Ltd.* to provide a current of 24 amps at 60 volts.

Discussion

Although the techniques of using V.I. have only been partially explored as yet, the construction and operation of three separate experimental cameras has led to a number of conclusions regarding what the method will do and what it will not do.

Tonal Rendering: In the first place the availability of a perfectly symmetrical form of lighting makes it possible (a) to adjust tonal reproduction to conform to an arbitrary plan by judicious control of three factors, namely: exposure, development and emulsion characteristics; (b) to subject a series of similar specimens to identical conditions of lighting and placement, in this way making their dissimilarities more apparent, and in addition being able to duplicate these same conditions at any time and for any other series of specimens.

As regards the exaggeration of tonal rendering, a specimen illuminated by oblique light (Figure 1A) must be printed to reproduce the original tone values in so far as the negative will permit. In this example general contrast has been increased, highlight areas are blocked, overprinting leads to loss of shadow area into the background, under-

printing leads to loss of detail in highlight areas. In short, the image of the specimen and the image of the background are neither in *separate tonal ranges* nor are they separated by a tonal range. In example B the two tonal ranges are close together but not identical, and they are separated by a third tonal range — that of the dark line marking the periphery of the specimen. Whatever the latitude of the printing paper, image and background remain separate, and so with V.I. these problems of adjusting printing depth and contrast to the original do not arise.

A V.I. specimen image is contained within the tonal range created by one light source, and the width of this range can be largely controlled by development and choice of suitable emulsion. During printing it may be further controlled by choice of printing paper, unlike the image which is produced by two light sources — a keylight and a filler — whose distinct tonal ranges have to be kept in balance throughout processing. Interference reflections from white backgrounds is a problem yet to be solved with V.I. With 75% of the specimens no trouble occurs provided that the background intensity is not too great relatively to the brightness of the specimen. With the remaining 25% however no means has yet been found of wholly eliminating reflections in every case and for all surface textures. Dark specimens give most trouble, suggesting that background brightness should be reduced nearly to the brightness of the lightest part of the specimen. This would at least minimise reflections to a point at which they would not register on the print.

A convenient method of obtaining white backgrounds with V.I. is to mount the specimen on a sheet of finely ground glass, ground surface upwards, beneath which is a mirror reflecting upwards. If both ground glass and mirror are normal to the incident beam evenly distributed illumination results, and of an intensity suitable for white specimens. For slightly darker specimens a sheet of white paper is substituted for the ground glass, or the specimen may be mounted directly on the paper.

Exposures with V.I. are not critical. Almost identical prints may be obtained from negatives of widely varying exposure and development times. In calculating exposures strip tests are made at intervals of 1-3-9-27 . . . , closer intervals not being required since, supposing that 9 was thought to be correct (*for the result desired*) any exposure between 7 and 11 would give nearly identical negatives. Even with process emulsions, which are most generally useful for this lighting, provided that exposures are full and development on the short side, exposure latitude is very wide. Contrast is adjusted at will by development and selection of emulsion; density is correct when the image contains maximum detail.

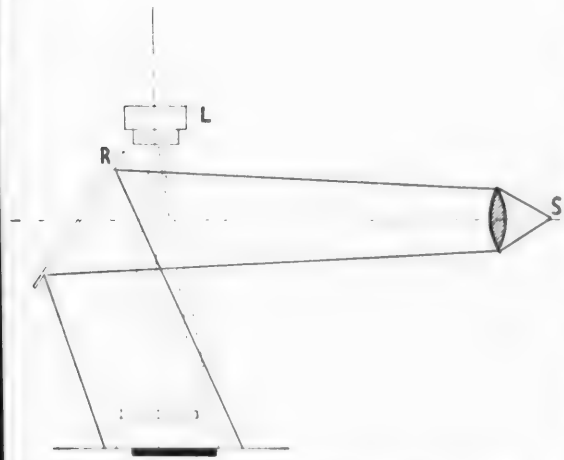
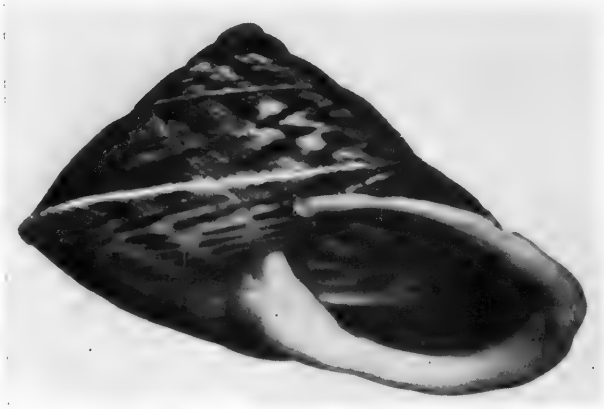


Figure 3(E). The Use of A Silvered Mirror Off-Axis.



Papuina Specimen. Glossy shell surface texture. Reflections eliminated by crossed polarizers.

Alignment of the light and camera axes is easily brought about by centralising the image on the focusing screen by means of an ink mark on the ground glass side. The light beam is now centralised by centering the specimen within its shadow. The lens is focussed and stopped down until the background plane is fairly sharp. Two strips of black card are now moved over the background in towards the specimen until their edges appear, on the focusing screen, to touch the specimen on opposite sides. The light source is now adjusted until the shadow is midway between the card strips. The same is done for the other pair of opposite sides.

To simplify the making of line drawings of molluscs and fish, photographs are made by V.I. from which matt prints are made, rather light in tone and soft in contrast. These pictures establish exact proportions and contain full detail over which the draughtsman works with indian ink. The photograph is then bleached out with ferricyanide and hypo leaving the line drawing which is then copied and a print sent to the blockmaker. This procedure has both speeded up the production of line illustrations and eliminated much of the measuring and scaling which has hitherto been necessary. V.I. provides an ideal form of lighting for such pictures since it is flat and shadowless and the range of specimen tones may be increased or reduced at will to suit the draughtsman's requirements.

Summary

The construction of a simple camera-illuminant unit which enables small opaque specimens to be illuminated vertically and photographed by a flat shadowless light, and permits the reproduction of identical photographic conditions for any number of similar specimens, assists the scientific illustrator by providing photographs suitable for reproduction of specimens which have hitherto had to be drawn, and by providing exact and detailed representations of specimens from which drawings can more quickly and easily be made.

The apparatus described was designed primarily to facilitate the accurate photographic recording of the shells of Mollusca. The application of vertical illumination is new to this kind of work, it is believed, hence the modifications of vertical illumination to photomacrographic cameras and the practical problems which arise are fully discussed. This apparatus is considered an improvement on previous cameras with independent lighting sources and is used on a wide variety of museum specimens.

Acknowledgment

The author wishes to thank Dr. R. A. Falla, Director, Dominion Museum, Wellington, New Zealand for permission to publish this paper.

Reference

1. Fundamentals of Optics, Jenkins & White, 2nd Ed., McGraw-Hill Pub. Co., 1951, p. 80, *et seq.*

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Exposure Evaluation From Photometer Measurements In Multiple Lens System Photography*

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Introduction

IN the title of this paper we have purposely used the expression *exposure evaluation*, in preference to *exposure determination*, because *determination* too strongly implies that satisfactory exposure can be arrived at through light measurements alone. In spite of the number of workers who have presented exposure techniques based on such a concept, we consider it misleading, since frequently *judgment* is just as important in ascertaining what exposure to give as are the physical data. This becomes apparent when one lists, for example, the major exposure considerations in photomicrography, which is just one of the many applications of photography where a multiple lens system is employed. The following considerations are involved:

1) What part, or parts, of the total field are most significant to record for,
   a) structural detail
   b) accuracy of color or density reproduction?
2) What physical measurements are necessary to derive a satisfactory exposure?
3) At what position in the system is it best to make the physical measure-

Figure 1

* Received for publication Jan. 20, 1953.

ments, and what are the equipment requirements?

4) What — if any — is the preferred range of exposure times to work within?
5) How can the exposure timing be accomplished, or how, in some instances, can the illumination be changed to establish an exposure time period that is realizable?

It is our aim to show that consistently satisfactory exposures are possible in photography, regardless of the complications introduced by a multiple lens system, provided a logical approach to the problem is taken to obtain the correct answers to the above questions. We recognize that there is nothing really new in what we have to present. What prompted us to demonstrate by actual test results, facts long since known to many qualified workers, is the frequent appearance of papers on exposure determination in photomicrography that point clearly to a general lack of understanding of the problem.

Historical

A review of the literature shows that *exposure* in photomicrography, in all its aspects, has presented numerous difficulties. We are still confronted with many of the limitations which faced earlier workers, but not always to the same degree. Collecting sufficient energy from the initial light source for all situations in photomicrography remains a problem. The decrease in light energy in passing through the complex optical system is as great as ever. Black and white film speeds have been increased, but color films, which are so widely used today, are only about one-half the speed of the fastest black and white films in use over two decades ago, and have less exposure latitude.

Unlike some other fields of photography, it has never been practical in photomicrography to derive satisfactory exposure values by knowing the intensity of the initial source. It is necessary to have a measure of the vastly reduced light energy after it emerges from the optical system. The evaluation of exposure from such physical light measurements is a comparatively recent development. It had its beginning shortly after the introduction of photovoltaic cells for light measurements in general photography. But whereas these photosensitive cells had adequate sensitivity for measuring the intensity of light sources or the light reflected from fairly brightly illuminated subjects, they were not sufficiently sensitive to provide a completely practical light measuring instrument for photomicrography.

Gross and Johnson described the use of a photoelectric exposure meter in photomicrography in 1933.* L. G. Henbest followed the year later with a more elaborate discussion. Further additions to the literature were made in close succession by a number of workers. Out of necessity these workers were compelled to measure the light energy near the ocular because the dimunition of light was so severe that measurements could not be made always in the image plane. This meant that exposure times were based on a collective measure of the light transmitted by all parts of the microscope field, followed by a mathematical calculation to allow for the fall off in the light from the plane of measurement to the image plane.

Wieland prepared charts to relate near ocular light intensities with those at the image plane for bellows extensions rang-

* References in this paper are given on page 33 in chronological order.

ing from 25cm to 50cm. Michel considered this approach inconvenient, and not necessarily the most accurate. He proposed the measurement of the light intensity within the microscope tube to obtain a value for the image projected by the objective. By means of a scale comparison between the objective formed image and the groundglass image, factors can be established for deriving exposure times once empirical tests are made to standardize the system for specific conditions.

Michel stressed the errors that can arise from "integrated" light measurements. For example, if the general surround area of the section in the microscope field is of low density and the significant parts rather dense, a measure of the total light transmitted by the field is not a suitable criterion to obtain a satisfactory exposure for those parts in the section of main interest. Michel, as well as Loveland, recognized that the ideal method for deriving exposure time in photomicrography was to measure the light intensity directly in the image plane. Loveland advocated the use of a sensitive photometer incorporating an emission photocell and amplifying unit. No doubt this thought has occurred to many others, for it is certainly obvious that the most meaningful measurement for evaluating exposure is one made in the area of main importance, at the plane where the light reaches the photosensitive material.

If all cross sections or opaque specimens presented to the photomicrographer were of one kind, where it is required only to record as closely as possible the visual image presented by the microscope under given conditions of technique, the problems of exposure in photomicrography would be greatly reduced from what they are. This not being true, the photomicrographer must know either from experience or from discussion with his colleagues precisely what is of most significance to retain — or to even exaggerate — within the specimen areas to be photographed.

It is not the purpose of the present paper to treat fully this phase of the subject. However, it must be introduced as an important aspect of exposure evaluation. A dense area with barely discernible structure that is to be photographed so that the structure is readily evident has to be evaluated in a different way from a dense area that must be recorded as dense in relation to other parts of the field. The same sort of situation exists in color photomicrography when a given area which has only slight color differentiation between its structural parts must be reproduced to show that order of color differentiation, regardless of the degree of accuracy in reproducing the rest of the field, as opposed to the colorful section which is to be reproduced for its overall appearance.

Since the judgment that tells one when and to what extent to deviate from the exposure indicated directly by physical light measurements is gained from experience it is not possible to give here more than general directions.

The Basic Problem

We are all familiar with the fact that as the area to be photographed becomes smaller and smaller, it becomes increasingly difficult:

a) To illuminate it properly.
b) To utilize the full intensity of illuminant.
c) To transmit a practicable proportion of that intensity.

This situation exists because:

a) It is necessary to provide a separate

lens system whose specific function is merely to direct the light to the object.

b) Such a lens system cannot fully accept the entire emission angle of even the best presently available light source.

c) Regardless of its optical quality, all glass causes a loss of light transmission.

d) A very critical and delicate balance exists between light source emittance angle and angle of acceptance of the associated optics.

e) Because the essential need is brightness per unit emissive area, we cannot hope for any greater help in our work until this circumstance changes; until such time, it is a mistake to anticipate a proportional increase in illumination with an increase in lamp power.

The Multiple Lens System

It is the presence of this secondary lens architecture that can be described as a "multiple lens system" which has presented us with so many problems in the wake of its advantages. In a multiple lens system, the intensity of a beam of light comes from a light source and passes through collectors and condensers all arranged for the express purpose of filling the aperture of the awaiting magnifying system. The lenses providing the illumination may be just as important as the more familiar magnifying optics. Unfortunately, as was previously pointed out, large increases in luminosity in the primary source result only in small additions to the intensity at the image plane. As the magnification ascends, and the complexity of the optical system becomes exaggerated, each intensity increase is further diminished in its journey through the apparatus. We are faced therefore with another of the great adversities frequently encountered in nature — that raising the intensity of the source does not mean raising the intensity at the image plane even proportionately. Under such circumstances we must of necessity waste great portions of our store of luminous energy to maintain what levels we can — levels frequently so low at the plane of the film that the eye can no longer distinguish detail adequately.

Outline of General Considerations

Before turning to the other techniques we decided to begin our tests in the extremely low light levels in photomicrography. We felt that if all the requirements for the photometer were met here the answers in exposure evaluation would then be equally available in all the other photographic systems. Throughout our work we were concerned not only with the practical applications in photomicrography, but more fundamentally with the solution for the entire realm of low level photometric evaluation — therefore, potentially, every other similar photographic problem. That is the reason for our insistence that the same apparatus should be equally useful in numerous photographic exposure techniques. Our past experience and preliminary experiments showed us that in order to accomplish this we must investigate the following:

1) Criteria for Exposure Evaluation
   a) What to look for in the specimen to determine the exposure.
   b) Interpretation of the data and changes for specific purposes.
2) Instrumentation for Exposure Evaluation
   a) Division of apparatus according to sensitivity.

b) Relation between illumination level and apparatus capable of reading that level.

c) High level illumination and use of conventional exposure meters.

3) Other General Considerations in Exposure Evaluation
   a) The light source.
   b) The photographic emulsion. (Emulsion sensitivity and exposure requirements; low level illumination and reciprocity failure; problems of color film; voltage stabilization; problems of black and white film.)
   c) Relation of negative processing to exposure determination.
   d) The filter-film correlation.
   e) The filter position.
   f) The instrumentation for timing the exposure.

4) Special Technics
   a) Extremely low level illumination. (Measurement at the 5 cm area and conversion of reading to film plane exposure.)
   b) Polarized light.
   c) Darkfield and Phase.
   d) Fluorescence.

Exposure Evaluation in Photomicrography

The problems of proper exposure evaluation in photomicrography were born immediately after the camera was affixed to the microscope ninety odd years ago. It is a question that has grown in importance over the years, and with the advent of color films its solution has become imperative. Moreover, the problem has expanded in scope as well, for technics are presently employed that are valuable to enabling substance identification and quantitative evaluation of cellular components to be made by means of density measurement. Thus one branch of cytochemistry utilizes most frequently the measurement of transmitted light for differentiation rather than for purely exposure control. In this paper we are concerned with light measurements of specific regions for exposure evaluation.

The need for a universally acceptable solution to the problem has become more acute as technical advances in emulsion manufacture have made possible films,

1) Of very high resolution, short gradation.

2) Capable of more accurate subject color reproduction.

3) More specifically sensitive to nonvisible radiation: infrared and ultraviolet.

Naturally such advantageous materials are more costly, so that it is impractical to use trial and error to judge the required exposure, especially when larger color films are used. Unfortunately too, the processing of the film often must be entrusted to the manufacturer with possible delays as great as one to two weeks; and time is often a factor of far greater consequence than money. Therefore the literature on the subject has flourished. Fortunately for us the crying need for proper instrumentation to measure low light levels in so many scientific fields has attracted the attention of engineers where a logical solution to the problem is most readily available — electronics.

In all of the previously described methods, various means have been used to ascertain proper exposure. We may list these as follows:

1) Trial and error, i.e., exposures on separate negatives or multiple exposures in steps on a single negative.

2) Conventional photographic exposure meters; e.g., DeJur, G.E., Weston, Norwood.

3) Photoelectric apparatus built to specifications (photocell - galvanometer combination).

4) S.E.I. and similar extinction type meters.

5) Phototube with D.C. amplification; e.g., Photovolt and Aminco.

6) Phototube with A.C. amplification; i.e., Densichron.

A number of factors help to complicate the problem. These include:

1) The nature of the specimen. (In biological microscopy the object may vary in thickness from less than 5 to more than 50 microns; the color density from none at all, or very slight dye (as in supravital staining) to intense, deeply colored metallic impregnation. The initial magnification may vary from 1 to 1500 times, and the size of the photographic film from 16 mm to 8 in. x 10 in.).

2) The intensity of the illumination. (The technics may evolve about transmitted light alone, polarized light may be used and, in special instances, darkfield employed. As is well known, the last two methods have tremendous influence upon the illumination intensity. When we must use incident illumination at high magnification, only a carbon arc may provide enough light).

3) The spectral characteristics of the light source. (This influences directly the reading that may be obtained from any particular type of meter due to the spectral sensitivity of the phototube or photocell.)

The Choice of Photometer

Logic directs the choice of that photometer which will read directly in all circumstances outlined above. Such an instrument should have the following characteristics:

1) It should be sensitive to a light intensity range of at least 1 to 10,000.

2) The spectral response of the phototube or photocell should be as flat as possible.

3) The meter reading should be immediate and constant.

4) The meter should be large, easily read and the reading readily translatable into intensity units. The photocell or phototube should be designed for use with any apparatus and with easy access to ground glass or eyepiece.

5) The reading of any particular spot should not be influenced by subjective considerations.

6) The instrument should not be too delicate, have a long life span and not be too costly.

It is valuable to discuss first the solution of the problem for those of us whose photomicrographic schedule is simple, the light intensity comparatively high and the camera close to the eyepiece; i.e, with conventional transmitted light and 35 mm color film. Since the conditions may vary very slightly, the required meter sensitivity may be obtained with the conventional photographic exposure meter. His instrument may then be used either:

1) To indicate the exposure at any particular reading, or

2) To govern the change in light intensity to a specific level and known exposure.

The first method is much to be preferred. The second involves too many compromises and is too difficult to apply to lamps which are not rheostatically controlled. An exposure chart for use with the Weston Meter for Ansco Color and Kodachrome 35 mm film can be determined in a short time and will be found useful over the following range:

Meter Reading	*Exposure*
13	1/64 second
6.5	1/32 second
3.2	1/16 second
1.6	1/8 second
.8	1/4 second
.4	1/2 second
.2	1 second

The above readings are obtained by placing the meter at the ground glass. The size of the image on the screen is kept slightly larger than the area covered by the 35 mm film. The distance from the ocular will vary slightly with each type of ocular and with different eyepiece powers. It will be seen that the sensitivity of the meter barely includes the 1 second value and from this point to 1/2 second is passably correct; however, from 1/2 second and shorter times the scale is somewhat more reliable.

The photomicrographer owes much of his success, therefore, to the great latitude of his films. Even color films possess a little of the leeway so necessary to the technician who lacks the very exact light measuring instrumentation required — a very fortunate situation, indeed, because the task of providing *just* the proper amount of light only for exposing the film is as great, if not greater, than the problem of determining that amount.

Criteria for Exposure Determination

Since the Weston and similar meters must be used close to the ocular, more sensitive instrumentation must be sought for larger film sizes and greater bellows distance. However, before continuing, it is important to note again the criteria for exposure evaluation. If the specimen is to be reproduced with the least possible deviation from the overall color and density values in the original, all factors must be very exact and tolerances must be kept very small, otherwise significant loss in fine detail of cell structure may result. In the case of special stains where change in hue indicates variance in chemical structure, the greatest care must be taken in reproduction. The proper exposure, therefore, depends upon the specimen and upon what we seek in the specimen. If a very dark stained cell is to be photographed in a rather light surround, the detail in the cell will be obtained if the exposure is determined for its density and the surround may have to be compromised. If, however, the surround is most important, then the opposite may hold true. Moreover, it is valuable to be able to gauge the exposure for a particular area density so that desired changes may be effected in the photograph at will. Such readings are only possible with a photocell which is designed to pick up comparatively small areas. Once the density values of a particular area are obtained, the technician has at his disposal the utilization of this knowledge to change his densities in the photograph for a specific purpose.

Equipment for Light Measurements In the Image Plane

In the past few years several photoelectric photometers of the phototube-amplifier type have been introduced that have adequate sensitivity for making light measurements in the image plane of the photomicrographic camera. For the examples given in this paper, the Welch

Densichron was used, although the Photovolt, Amnico, Ansco-MacBeth Color Densitometer, etc. have all been recommended as suitable instruments. We chose the Densichron* because of its excellent stability characteristics that appear to be the result of its unique magnetic modulation of the phototube current, which allows the application of an A.C. amplifier. It is a simple device to operate, having no elaborate controls. It consists of a meter furnished with both log and linear scales, which may be used independently mounted on the front of a metal housing 5 in. x 7¼ in. x 13 in. Below the meter is a range switch and a volume or gain control which sets the pointer to the level of light intensity. Both controls are set in a plastic plate which is illuminated by an internal dial light for easy visibility in the darkroom. At the side of the metal housing is an Amphenol plug to which the probe cable of the Densichron photocell is attached. Provision is made on the back plate of the housing for mounting a jack to connect an external meter or recorder apparatus. A four point Amphenol plug provides an output signal for auxiliary equipment such as an A.C. vacuum tube voltmeter, phototimer, a scale expander or other specially built equipment. A "no-signal" adjustment is made by means of a recessed hole in the rear of the Densichron and here adjustment is possible for least indication on the meter.

The Densichron Sensitivity and Phototube Response

The spectral sensitivity curves for the probes are shown in Fig. 2. The blue probe was used throughout for all measurements in this paper except, when it was necessary to work with a sharp cutting red filter where it was found more convenient to replace the blue with the red probe. With the exception of fluorescence photography no filter was used with the probe. A Kodak Wratten gelatin filter No. 106 may be interposed to further flatten the phototube response.

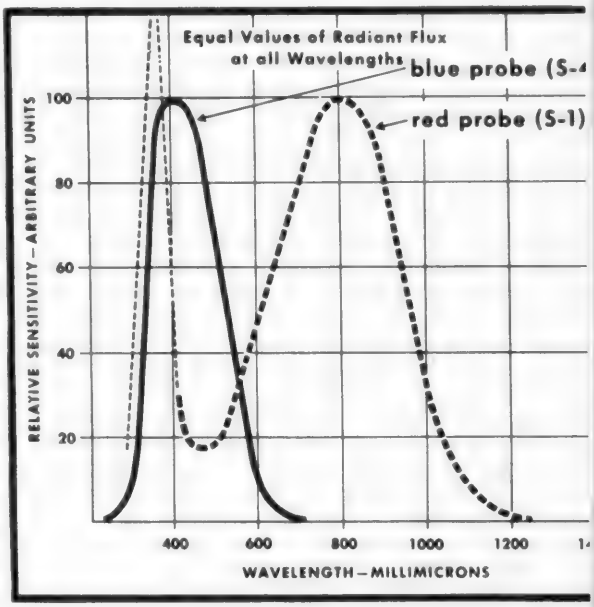
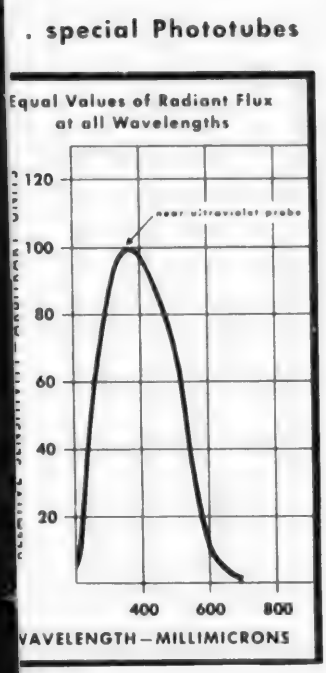


Figure 2

Using the S.E.I. extinction meter the intensity range of the blue probe was approximately established. Fig. 3 shows the scale limits of the phototube in candles per square foot as we limited the instrument to our particular application. The full range of the instrument scale is shown in Fig. 4. The values obtained in each of the three arbitrarily chosen positions can be visualized. Rear dial (back setting) position 0 is the least sensitive phototube-meter combination; setting 80, the most sensitive; whereas setting 23 provides a convenient medium combination. The areas where these three ranges overlap are readily seen. By

* Available from W. M. Welch Mfg. Co., 1515 Sedgwick St., Chicago 10, Ill



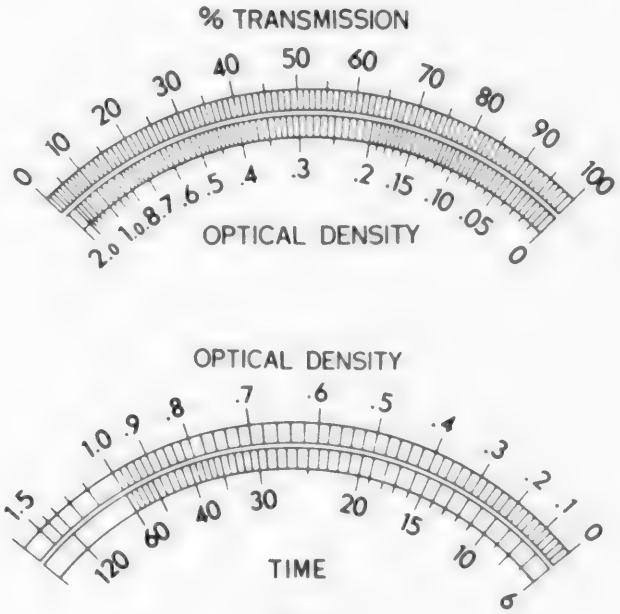


Figure 4

using three special phototubes, the response of the Densichron to light sources with widely differing spectral characteristics is considerably increased. The instrument provides a light intensity range measurement of 1 to 10,000.

Extension of Densichron Sensitivity

For reasons previously described, the response of the Densichron phototube is, in our work, limited by the intensity of the light at the ground glass. The lower limit of this response is reached when the phototube is confronted with illumination of less than approximately .001 candles per square foot measured at the ground glass. This does not mean that the usefulness of the Densichron has ended at this point. We have only to move the phototube to that plane in the system where the light intensity and beam diameter are both sufficient to activate the phototube and large enough to permit discrete readings of the image. Now we utilize the conventional methods of computation with an important distinction — that by using a smaller aperture with the same phototube, the area on the ground glass which we measure may be much smaller *while the image intensities still remain discrete.* Because this small diameter exists so much closer to the primary magnifying lens system, the great fall-off of light in projection is avoided and the response to the phototube very considerably increased. We have only to take this reading and simply compute the value for the distance to the actual image plane.

In a multiple lens system, when light intensity measurement must be made in a plane other than the final image plane, the following point must be considered: the area of illumination to be measured should completely cover the diameter of the phototube. The final exposure at the

COMPARISON OF LIGHT SOURCES FOR PHOTOMICROGRAPHY

APERTURE AND FIELD FILLED EQUALLY IN ALL CASES

Item	Light Source General Type	Light Source Kind	Current (Amperes)	Color Temperature	Illuminance in Foot-candles		Integrated Illuminance *	
					White Light *	Green Light †	For Total Flash	For 1/100 sec (exactly)
1	Incandescent Tungsten	Ribbon Filament	18.0 A.C.	3000 K	2.46	0.27		4
2	Incandescent Tungsten	Coil Filament	15.5 A.C.	3000 K	3.64	0.39		6
3	Incandescent Tungsten	Coil Filament	18.0 A.C.	3400 K	7.65	0.975		13
4	Incandescent Tungsten	Siemonds "Solid Source" 12V 150 Watt	12.5 A.C.		6.60	0.76		
5	Incandescent Tungsten	Siemonds "Solid Source" 24V 250 Watt	10.4 A.C.		7.70	0.92		
6	Incandescent Tungsten	Siemonds "Solid Source" 24V 400 Watt	16.65 A.C.		7.49	0.86		
7	Tungsten Arc	Pointolite	1.5 D.C.		2.95	0.325		5
8	Tungsten Arc	G.E. Tungs-arc	A.C.		8.29	0.97		15
9	Zirconium Arc	Mikrark (I.C.)	rectified A.C.		10.5	1.32		17
10	Zirconium Arc	Western Union Lamp	6.2 D.C.		14.3	1.72		23
11	Zirconium Arc	Western Union Lamp	8.0 D.C.		16.2	1.90		26
12	Carbon Arc	Clockwork	4.5 D.C.	3645 K	27.2	3.39		47
13	Carbon Arc	8mm anode	10.0 D.C.	3820 K	43.7	5.40		76
14	Carbon Arc	High Intensity	38.0 D.C.	5800 K	55.0	11.40		122
15	Mercury Arc	AH_3 85 Watt	A.C.		1.75	0.46		6
16	Mercury Arc	AH_4 100 Watt	A.C.		1.01	0.22		
17	Mercury Arc	Compact (English) 250 Watt	4.4 A.C.		32.5	7.41		130
18	Control	Photoenlarger Lamp #111 (115V)			0.04			
19	Flash	G.E. No. 5		3800 K			(1 50 sec) 130	65t
20	Flash	G.E. SM		3300 K			(1 200 sec) 26	52t
21	Flash	Xenon		Daylight			(1 3000 sec) 165	5000t

*The uv was eliminated by a Kodak Wratten 2B Filter in all cases.

†Filter: Kodak Wratten 77A for Hg arcs; Kodak Wratten 58 for all other sources.

tCalculated value for comparison only.

TABLE I.

We are indebted to Mr. Roger P. Loveland of the Eastman Kodak Research Laboratories for the data compiled in this table. The relative amount of light obtained from the various sources can be readily compared.

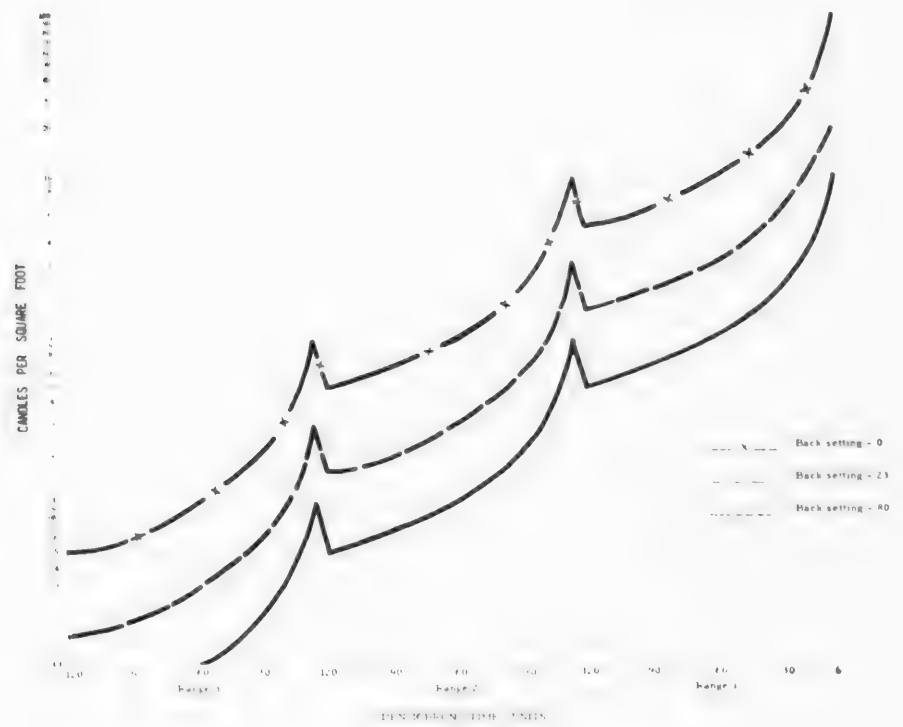


Figure 3

image plane may be calculated by one of the following methods.

Method I

Establish the ratio of the distance from measurement plane to eyepoint to the distance film plane to eyepoint. Calculate the final exposure as follows:

$$X_f = X_m \left(\frac{D^2}{d^2} \right)$$

where:

X_f is the exposure value in time units at the film plane

X_m is the exposure value in time units at the measurement plane

d is the distance from the eyepoint (or analogous plane) to the measurement plane

D is the distance from the eyepoint (or analogous plane) to the final image plane

Method II

Establish the ratio between the diameter of the measured area and the diameter of the image plane illuminated area. The conditions of Koehler illumination must be met. Using the above formula, calculate the final exposure at the image plane merely changing the definition of the terms as follows:

d is now the diameter of the photocell (which is approximately equal to the diameter of the measured area)

D is now diameter of the illuminated field in the image plane

Both methods are based on the inverse square law of light intensity decrease with distance. Complete discussions of

EXPOSURES CALCULATED FROM DENSICHRON READINGS

Back Dial Setting — 80 Film Speed ASA 10

Relative Time Scale Position 3	60	50	45	40	35	30	25	20	15	10	7	6
Exposures in seconds	60	50	45	40	35	30	25	20	15	10	7	6
Position 2 Exposures in seconds	6	5	4½	4	3½	3	2½	2	1½	1	7/10	3/5
Position 1 Exposures in seconds	3/5	½	9/20	2/5	7/20	3/10	1/4	1/5	3/20	1/10	7/100	3/50

TABLE II.

The readings on which this table is based were made on a modified form of the standard Densichron instrument. These modifications consist of: 1) The toggle switches that control the front decades of the standard Densichron were replaced by push-button micro-switches. 2) In place of the four decades on the front of the standard instrument, there are three decades on the front and a fourth decade on the back of the modified version, calibrated from 0 to 80.
The exposures were calculated as follows: The back dial was set on an arbitrary position, for example, 80. A typical specimen was chosen and several test exposures were made. The best of the series was selected. The illumination intensity at the ground glass was then read with the Densichron. The previously determined exposure was correlated with the time scale of the instrument and used as a reference point for further calculations. Since the relative time units (6 to 60) progress in linear increments it is easy to calculate the absolute exposure for any other reading within the same front position, for instance, position 1. The exposure values increase from position 1 to position 2 by a factor of 10 and from position 2 to position 3 again by a factor of 10.

this law may be found in many previously published papers.

In the prepared charts and tables, method I was used and the exposure factors $\frac{D^2}{d^2}$ were determined for distances of 5 cm, 7.5 cm and 10 cm from the eyepoint. It was found that the optimum distance of the plane in which the illumination level should be measured varied with the magnification of the ocular. The optimum values were found to be:

Ocular Magnification	*Optimum Distance from Eyepoint*
5x	5 cm
10x	7.5 cm
15x	10 cm

Table 3, related to the curves in Fig. 5, shows the direct exposure factors for these three oculars at bellows extensions of from 10 to 50 cm.

In order to utilize the optimum acceptance angle of the phototube, Densichron apertures of different diameter were tested and it was found that 7mm aperture gave the best response.

Other Considerations in Exposure Evaluation

Black and White Films

The interchangeability of apertures in the Densichron probes makes it possible to measure very small areas. This fact can be used to great advantage in cases of complex low level illumination such as, fluorescence, darkfield and phase contrast and even in copying x-ray films. The old rule of thumb "expose negative material for the shadows and reversal films for the highlights" can now be modified for much greater accuracy and higher tolerances. It is no longer necessary to expose for one extreme or the other. Using an aperture of small diameter, it is possible

EXPOSURE FACTORS FOR PROGRESSIVE MAGNIFICATION

Readings Taken at Three Predetermined Distances from the Eyepoint

Bellows Extension — Measurement from Eyepoint in cm.	d 1 = 5cm	d 2 = 7.5cm	d 3 = 10cm
	Exposure Factors		
10	4		
11	5		
12	6		
13	6.6		
14	7.6		
15	9	4	
16	10	4.6	
17	11.5	5	
18	12.8	5.8	
19	14.5	6.4	
20	16	7	4
21	18.7	7.8	4.3
22	19.8	8.6	4.8
23	21	9.4	5.3
24	23	10	5.7
25	25	11	6.25
26	27	12	6.75
27	29.5	13	7.4
28	31.5	13.9	7.8
29	33.5	14.5	8.4
30	36	16	9
31	38.5	17	9.6
32	41	18	10.2
33	43.5	19.4	10.9
34	46.5	20.5	11.5
35	49	22	12.2
36	52	23	13
37	55	24.5	13.7
38	58	26	14.4
39	61	27	15.2
40	64	28.5	16
41	67.5	30	16.8
42	70.5	31.5	17.6
43	74	33	18.5
44	78	34.5	19.4
45	81	36	20.3
46	84.5	37.5	21
47	88	39	22
48	92	41	23
49	96	42.5	24
50	100	44.5	25

TABLE III

to expose for any intermediate density range desired.

Because black and white films have such a wide range of gradations and variation of color response, it is advisable to correlate the response of each individual emulsion with the Densichron readings. Once this relationship is set up for any emulsion and a specific processing system, consistent results may be expected. Since the processing plays such an essential part in the overall balance, its function should be regarded with the same care as the rest of the factors.

Color Films

To obtain the proper exposure for color film, it is necessary to consider first the color density distribution in the specimen and, secondly, the ultimate use of the finished color transparency. As late as 1952, papers have advocated the method of photocell reading of the naked light beam measured through a blank slide; or no slide at all. We cannot agree with this technique and, in fact, have seen that the Densichron can establish precise readings for any level of density in the specimen. It must be emphasized that the photographic reproduction of a subject composed of density levels will result in a film composed of similar density levels. The greater the care in the reproduction, the closer this similarity. Therefore, the need for reading at the required density level is even greater with color films because the shift in color balance and the impurity of specimen color separation is more manifest here than in the black and white films where the scale exists in grey tones.

The processing of the color film also has great bearing on the contrast values and color balance. The greatest care in establishing a proper exposure can be negated by the use of exhausted, contaminated, or non-temperature controlled

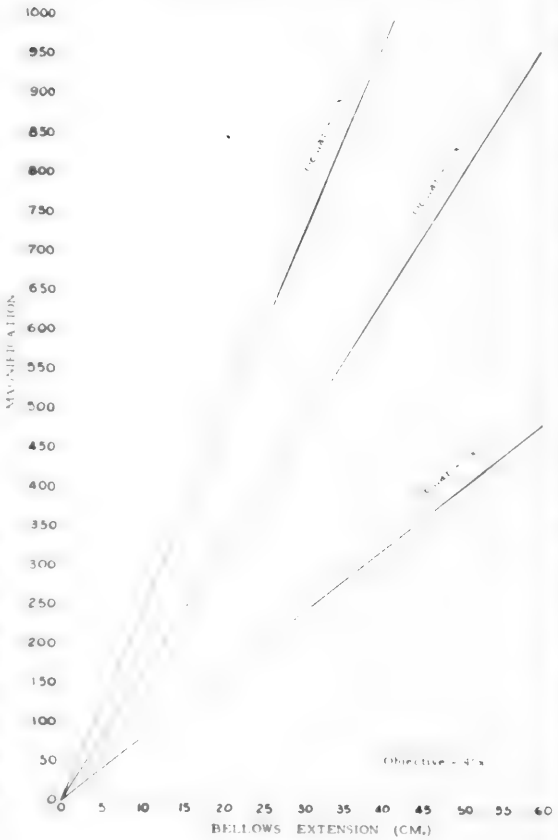


Figure 5

processing solutions. Improper processing timing can also upset the color balance and the contrast values. Nor must we dismiss the possibility of variations in emulsion speed and color balance from the manufacturer's data. It is therefore advantageous to purchase as large an emulsion stock as possible and perform the necessary tests to establish first the emulsion's sensitometric attributes so that this film can be handled safely in future work. This is not a new concept. This task is performed very carefully in all the large commercial studios.

The Film-Filter Correlation

The evaluation of proper exposure can be accomplished only if we take four

significant factors all into consideration. The first of these concerns the light source: its spectral emission and intensity; the second, as previously noted, involves the phototube or photocell — its spectral absorption and sensitivity; and the third is bound up with the film — its spectral sensitivity, speed, and processing. The factors involved in film processing should be considered separately. The fourth factor concerns the relative transmission-absorption characteristics of the filtered light beam and its relation to the specific film response. All these factors were recognized hithertofore, but the fourth has not usually been taken into serious consideration. To understand its importance, the following experiment was made: a conventional *Ansco* gray scale was copied. Two light sources and two emulsions were used. These were the 100 watt concentrated arc lamp and the cold cathode tube — *Azan-R*. Films employed were *DuPont Ortho X* and *Eastman Kodak Contrast Process Pan;* processing time 5 minutes in E.K. DK60, 68 F. The unfiltered and filtered light of the cold cathode were measured with the Densichron in the conventional manner, and the exposure relationship between unfiltered and filtered light was established as one to four. The *Ortho X* emulsion was exposed in this relationship; the two test sheets were simultaneously processed and the corresponding densities measured. The two test sheets matched closely enough for all practical purposes — within .02 density. The spectral response of the emulsion corresponds with the actual *Densichron* reading of the filtered light.

The gray scale was then photographed with *E.K. Contrast Process Pan* assuming that the same relationship exists. After processing and measuring the densities, it was observed that there were differences in the corresponding density readings. We must interpret such differences to show the necessity for establishing a required new filter factor for this particular film.

The filter factor is shown for the following filters:

Comparison of Densichron Readings and Actual Emulsion Color Sensitivity

Light Source, 100 Watt Concentrated Arc Lamp

Wratten Filter	*Densichron Filter Factor*	*Emulsion Filter Factor*		
		DuPont XF Ortho	E. K. Contrast Process Pan	DuPont High Speed Pan
C47 (blue)	7x	4x	20x	5x
B58 (green)	5x	5x	9x	6x
G15 (yellow)	3x	2½x	2x	2x
A25 (red)	20x		4x	3½x

It will be seen that the filter factor will be relatively small if the peak of the spectral response of the film and the spectral transmission peak of a given filter coincide. Conversely, the filter factor will be relatively high if the film has a subdued response to the spectral transmission characteristics of the same filter. Therefore the technician should prepare a chart which lists the factors of the filters he employs with his films. He will then be able to translate his meter readings with the exactness of the rest of his instrumentation. Similarly if it is necessary to use dyes of very high color saturation frequently, it would be equally advan-

tageous to determine the effect of these dyes for any given film.

The Filter Position

Continued study of the part played by the filter yielded further very interesting information. For example, the plane position of the filter could greatly influence the intensity of the transmitted beam of light. Small shifts of the filter position from the plane of perpendicular to the light beam produced variations in intensity readings. The conventional filter holder which has no provision for keeping the filter exactly perpendicular to the beam, may permit uncontrolled and therefore undesirable changes in the light intensity and, ultimately, the photographic negative density. In the case of interference filters, the problems arising become even more complex. The use of the Densichron while providing immediate recognition of the change of intensity may not correct for the change in inherent absorption so that regardless of the filter position, the phototube reads the amount of light transmitted. However, with conventional meters, where the sensitivity is inadequate to permit the light to be read with the filter in position, the variation in exposure may be quite large if the filter is positioned at random, and, depending upon the emulsion, may be even larger if the filter factor is calculated separately.

The Instrumentation for Timing the Exposure

Unfortunately, at this point in the report, we must pause to describe a situation where the instrumentation with which we work ceases to function adequately. It may logically be asked what good it is to know that the proper exposure is $\frac{1}{3}$ of a second or 1/7 or 1/35 or a second if it is impossible to obtain these exposures with the conventional shutters. The answer lies in the written statement quoted elsewhere that the insistence upon such high tolerances helps scout new photographic frontiers — it is one of the most important tools in new progress in photography. The solution of one problem almost inevitably opens the doors to others. This rich treasure trove is the delight of research. If it is profitable to turn to electronic shutters with much finer time increments, let us by all means do so.

The present shutter is therefore the next most logical candidate for basic instrumentation improvement. It is unfortunate that the technical photographer is handicapped by being forced to work with a tool shaped for specifically for the general photographic populace (whose needs it fits adequately). Meantime, it behooves the technician to make his own adaptation. One very good one is the use of a razor thin blade activated by an electronic timer. To best accomplish this, the blade should be small and placed in such position in the optical system where the diameter of the light beam is less than one inch. The thin steel blade can be mounted on a vibration-free base and attached to a solenoid connected to the electronic timer. Some personal ingenuity may be necessary to accomplish this, but the proven ability of most technicians to readapt their equipment makes the construction of such a small instrument quite feasible. A second method of enlarging the scope of the shutter is possible with the compur and some other types. Here the positioning of the shutter indicator enables small timing increments to be obtained. Although it is difficult to obtain known exact time intervals in this manner, the increments so realized will, however, be that much closer to the desired time schedule reported by the Densichron. In this way

we can obtain many fractions between $\frac{1}{2}$ second and 1/5 second, or 1/5 second and 1/10 second, etc.

However, the above discussion is predicated on the assumption that an individual shutter is being used. If more than one shutter is employed, the technician must consider the problem of general shutter variation and inherent differences in mechanics and design. Although it is not feasible here to discuss all of the problems connected with the shutter operations and tolerances, it is important to point out that the manufacturer's data provided with each instrument must be accepted with care and may change with age, room temperature, dust accumulation, etc. Since line voltage fluctuation may markedly affect the results, electronic timers should be used which are not affected by this factor.

Polarized Light, Darkfield and Phase

The use of any of these techniques brings up the same interesting question: where shall the phototube measurements be made? Regardless of the type of emulsion (negative or reversal) used, the background should certainly not be used for exposure density measurement. In all cases, the reading should be made not in the extinct background, but where the brightest intensities lie in the image plane. The same thought is true for darkfield and dark contrast phase.

Conclusion

The problems of evaluating correct exposure when the specimen is to be photographed with a complex lens system, so necessary in the reproduction of subject in medical and other scientific fields, becomes more involved than a mere effort to approximate a required exposure time with the usual apparatus available to the technician.

A phototube-amplifier system is proved capable of discerning intensity levels as low as approximately 0.01 candles per square foot. With such a meter it is possible to read accurately such levels of intensity at the desired image plane anywhere in the system. The values so obtained may be translated into actual exposure time to such tolerances that there is least possible distortion of these density values in the reproduction.

This apparatus may also be used to determine density values which are necessary in the new cytochemical substance identification techniques. The advantages of adhering to the highest tolerances and the necessity of raising all parts of the apparatus to the same high standards are emphasized.

It is hoped that this study will stimulate other investigations of the many aspects of this important problem; that the need for even more improved instruments will become manifest and that in the general tightening of tolerances which this will make possible, we will be rewarded by the increased standards of our methods, and therefore of our photographic results.

Acknowledgments

The authors gratefully acknowledge the assistance of Mr. Lloyd E. Varden for his suggestions during the final preparation of the manuscript; to Mr. Walter Linde, Electronics Department, Pavelle Color Incorporated, for calibration of the photometric equipment; to Mrs. Julius Weber we owe our gratitude for her help and patience in several typings of the manuscript.

ERRATUM

In a number of instances in this paper the authors inadvertently referred to DuPont *XF Ortho* film as DuPont *Ortho X*. The correction has been made wherever extensive resetting of type was not required.

ILLUSTRATIONS

To insure the most rigorous testing of the exposure evaluating method described in this paper, we prepared each of the photographs by means of multiple exposures on a single film. This was accomplished through the use of Zeiss *Multiplicator* which permits Kodak *Recomar* 9x12cm film holders to be moved across the image plane. A metal plate with the *Multiplicator* limits the size of the wedge slit while stops on the *Multiplicator* top determine the number of exposures. The actual exposures were made in the routine way. The specimen was arranged, all parts of the optical system checked and the *Densichron* readings taken at the ground glass in the *Multiplicator*. The ground glass was then removed, the film holder substituted and the exposure given. The next specimen or next magnification was arranged, the *Multiplicator* setting shifted and the above process repeated, all on the same film. Du Pont High Speed Pan film was used, except where otherwise noted. All processing was done in *DK60* at 68 F for five minutes.

Each exposure is identified by number to correspond with the numbers under the illustrations.

A) Printed matter. Euryplan: f/16

1.) 1½ sec. exposure
2.) 1½ sec. exposure
2.) ½ sec. exposure
3.) 2 sec. exposure
4.) 1¼ sec. exposure
5.) 2½ sec. exposure
6.) 1¼ sec. exposure

B) Radiographs. Euryplan: f/16 Du Pont XF Ortho

1.) 2 sec. exposure
2.) 5 sec. exposure
3.) 2 sec. exposure
4.) 2 sec. exposure
5.) 6 sec. exposure
6.) 5 sec. exposure

C) Stain spectrum. The flatness of the phototube spectral response is demonstrated by the series of six differently stained sections.

8mm — 10x ocular — no filter — Zirconium lamp

1.) Neuroglia, gold chloride 40 microns — purple 1/10 sec. exposure
2.) Connective tissue, trichrome — blue 1/10 sec. exposure
3.) Spirogyra, lichtgruen — green 1/10 sec. exposure
4.) Kidney tubules, picric acid — yellow 1/10 sec. exposure
5.) Fat, Sudan III — orange 1/10 sec. exposure
6.) Glycogen, Best's carmine — red 3/5 sec. exposure

D) Low power macrophotograph. Mold culture in incident light. Increasing magnification. Zirconium lamp.

1.)	35mm Microsummar	1 sec. exposure
2.)	42mm Microsummar	1 sec. exposure
3.)	50mm Microtessar	½ sec. exposure
4.)	64mm Microsummar	½ sec. exposure
5.)	100mm Summar	1 sec. exposure
6.)	120mm Microtar	1 sec. exposure

E) Low power photomicrograph. Transmitted light, fetal chick injection. 6 volt, 5 amp. lamp, Wratten B + G filters

1.)	100mm Microsummar	1/5 sec. exposure
2.)	64mm Microsummar	1/5 sec. exposure
3.)	50mm Microtessar	3/10 sec. exposure
4.)	35mm Microsummar	2/5 sec. exposure
5.)	16mm Microtessar	1/5 sec. exposure
6.)	10mm Microtar	1/5 sec. exposure

F) Onion root tip. Iron hematoxylin. Increasing magnification. Zirconium lamp. Kodak B + G filters

1.)	16mm 10x ocular	1/50 sec. exposure
2.)	8mm 10x ocular	1/10 sec. exposure
3.)	4mm 10x ocular	1/5 sec. exposure
4.)	3mm dry 10x ocular	½ sec. exposure

5.) 2mm oil 10x ocular 2 sec. exposure
6.) 2mm oil 15x ocular 2 sec. exposure

G) Foreign body crystals in tissue. Polarized light, rotation of polarization. Zirconium lamp.

1.) 1/25 sec. exposure
2.) 1/5 sec. exposure
3.) 2/5 sec. exposure
4.) 3/5 sec. exposure
5.) 4/5 sec. exposure
6.) 1 sec. exposure

H) Foreign body crystals in tissue. Polarized light, increasing magnification. Zirconium lamp. 15x ocular.

1.) 16mm ½ sec. exposure
2.) 8mm 2 sec. exposure
3.) 4mm 2 sec. exposure
4.) 3mm 2 sec. exposure
5.) 2mm oil 3 sec. exposure
6.) 2mm oil (bellows extended) 5 sec. exposure

I) Taenia Solium Scolex. Darkfield condenser, Leitz 1.20. 10x ocular. Du Pont XF Ortho

1.) 16mm Zeiss 2 sec. exposure
2.) 8mm Leitz 1 sec. exposure
3.) 4mm Leitz 1 sec. exposure
4.) 3mm Leitz 2 sec. exposure
5.) 2mm Leitz oil 6 sec. exposure
6.) 2mm Leitz oil (bellows extended) 13 sec. exposure

J) Eggs of tapeworm. Leitz Phase Contrast. 6 volt, 5 amp. lamp

1.) 16mm 1-2/3 sec. exposure
2.) 8mm 1-2/3 sec. exposure
3.) 4mm 1-2/3 sec. exposure
4.) 2mm oil 10 sec. exposure
5.) No exposure made
6.) No exposure made

K) Fluorescence in mineral crystals. Ansco UV16 filter foil over lens and Densichron probe. Woods filter over AO housing with AH4 mercury vapor lamp. Quartz condenser. Azan cold cathode lamp B providing general illumination over specimen.

1.) 6½ in. Meyer Euryplan Set IV Convertible 3 ½ sec. exposure
2.) 120mm Microtar 3 ½ sec. exposure
3.) 100mm Summar 4 sec. exposure
4.) 64mm Microsummar 6 sec. exposure
5.) 50mm Microtessar 7 ½ sec. exposure
6.) 35mm Microsummar 40 sec. exposure

L) Basswood Stem CS. Density variations obtained by shutter indicator positioning. 1/50 to 1/10 sec. in six parts.

1.) 1/50 sec. exposure
2.) Intermediate exposure
3.) 1/25 sec. exposure
4.) Intermediate exposure
5.) Intermediate exposure
6.) 1/10 sec. exposure

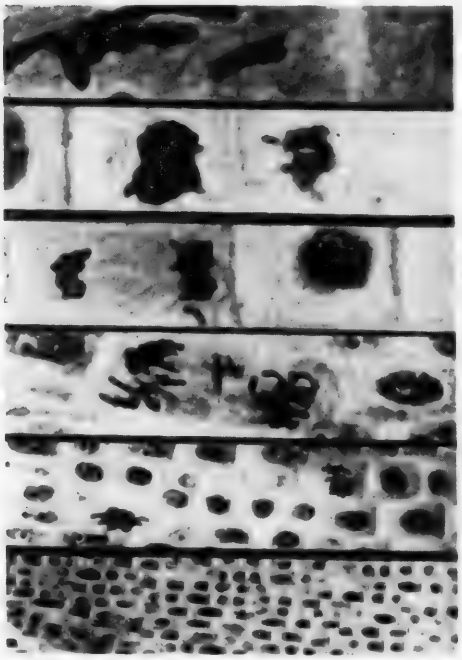
M) Nerve fibers. 40 microns, gold chloride impregnation. 5cm point calculation. Du Pont XF Ortho

1.) 15cm bellows extension 9 sec. exposure
2.) 20cm bellows extension 16 sec. exposure
3.) 30cm bellows extension 33 sec. exposure
4.) 40cm bellows extension 70 sec. exposure
5.) 50cm bellows extension 105 sec. exposure
6.) 60cm bellows extension 150 sec. exposure

N) Striated muscle. 5 cm point calculation. Du Pont XF Ortho

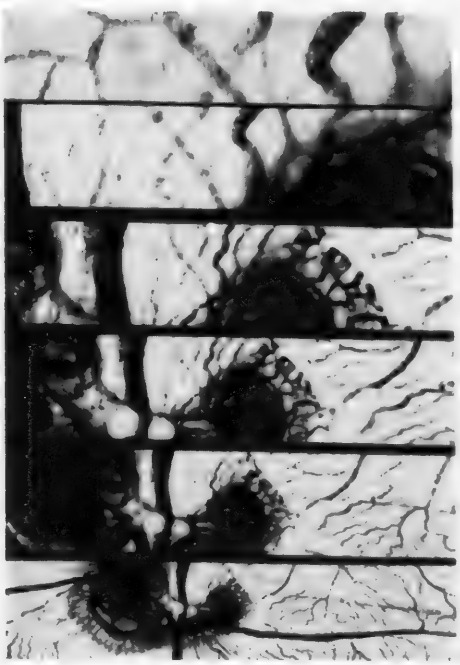
1.) 4mm 5x ocular 30cm extension 0.9 sec. exposure
2.) 4mm 5x ocular 50cm extension 2.5 sec. exposure
3.) 4mm 10x ocular 30cm extension 4 sec. exposure
4.) 4mm 10x ocular 50cm extension 11 sec. exposure
5.) 4mm 15x ocular 30cm extension 6 sec. exposure
6.) 4mm 15x ocular 50cm extension 17 sec. exposure

B) 1 2 3 4 5 6
D) 1 2 3 4 5 6
A) 1 2 3 4 5 6
C) 1 2 3 4 5 6



F)

H)



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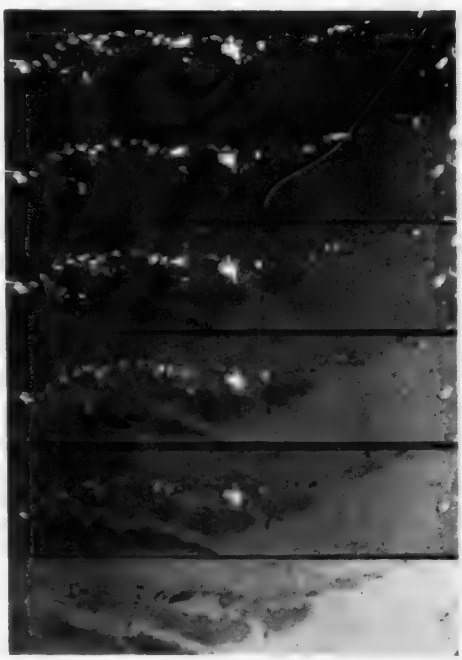

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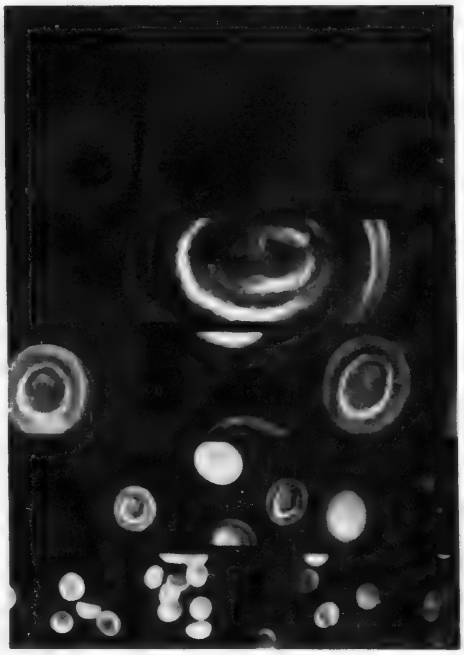
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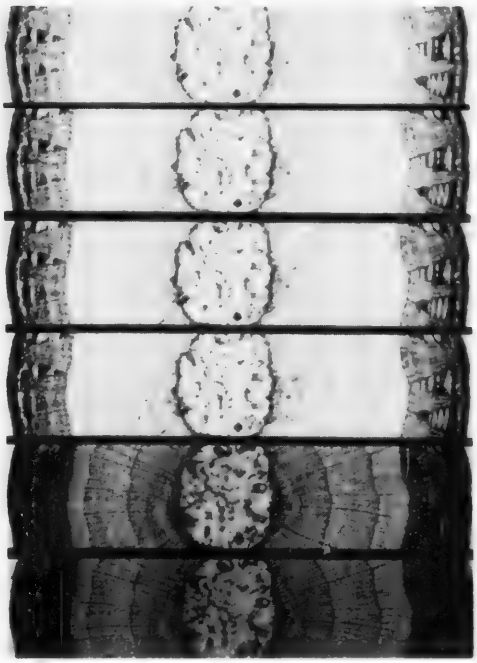
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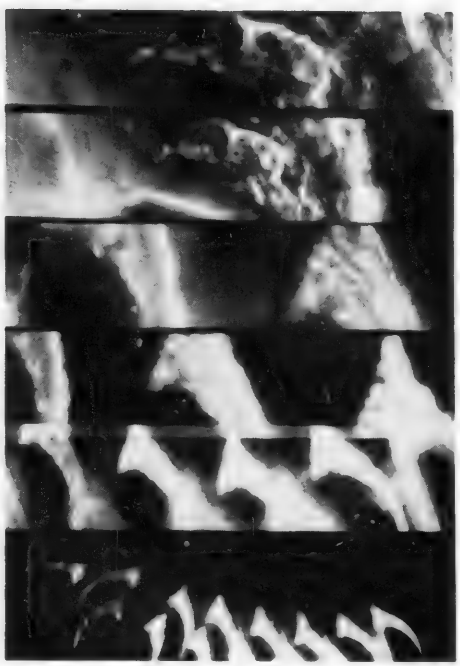
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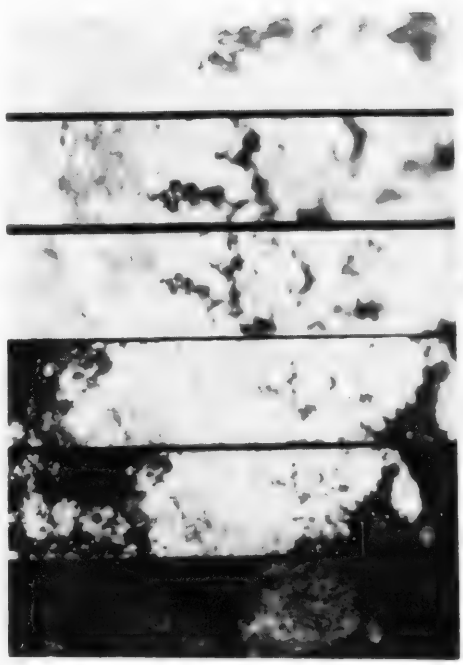
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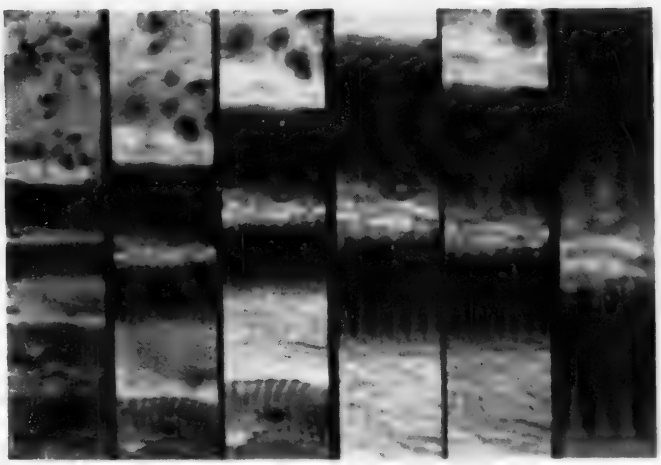


N) 1 2 3 4 5 6

REFERENCES

1933 Gross and Johnson: Photoelectric Exposure Meter for Photomicrography, J.B.P.A., 1, 172-192.

1934 Henbest, L. G.: Exposure Determination in Photomicrography, J.B.P.A., 3, 2-23.

1936 Wieland, M.: Ein Messverfahren zur Bestimmung der Belichtungszeit fuer die mikrophotographische Aufnahme. Z. wiss. Microskop. mikroskop. Tech., 53, 183-192.

1937 Weber, J.: Color Photomicrography. Leica Phot., 16, (Dec.).

1938 Graff, John H.: Determining Exposure Time of Photomicrographs with the Instoscope Exposure Meter, J.B.P.A., 6, 161-171.

1938 Earle, Wilton R., A Simple Photoelectric Exposure Meter for Use in Photomicrography, J.B.P.A., 7, 54-58.

1940 Michel, Kurt: Grundzuge der Mikrophotographie, Zeiss-Nachr. Sonderh., 4.

1941 Keinath, George: Photoelectric Exposure Meters, Photo. Tech., 3, 56-60.

1941 Flory, L. P.: Calculation of Film Speeds for Specific Processing Conditions, Photo Tech., 3, 54-56.

1941 Morton, Thomas H.: Determination of Exposure for Kodachrome Photomicrography, Phot. Tech., 3, 50-51.

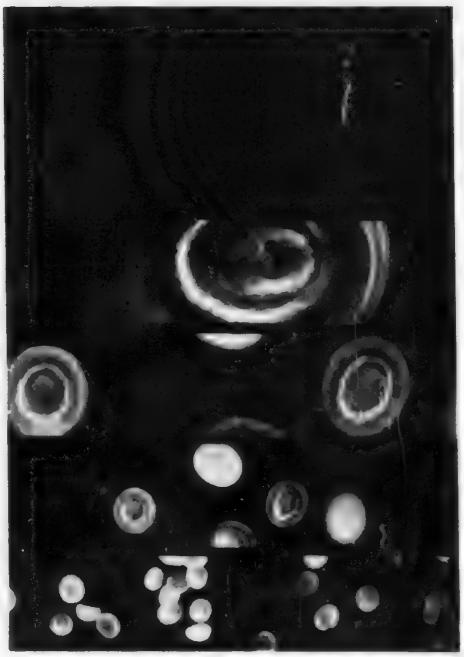
1943 Michel, Kurt: Handbuch der Wissenschaftlichen und Angewandten Photographie, Ergaenzungswerk, Springer-Verlag, Vienna.

1943 Kornhauser, S. I.: Experience in Kodachrome Photomicrography, J.B.P.A., 12, 47-53.

1944 Maurer, J. A.: Exposure Control in Photomicrography, J.B.P.A., 12, 173-185.

1944 Loveland, R. P.: Determination of Exposure in Kodachrome Photomicrography, J.B.P.A., 13, 79-97.

1952 Neubecker, Robert D.: A Simplified Technic for Taking 35mm Color Photomicrographs, U.S. Armed Forces Med. Jour., 3, 1055-1060.



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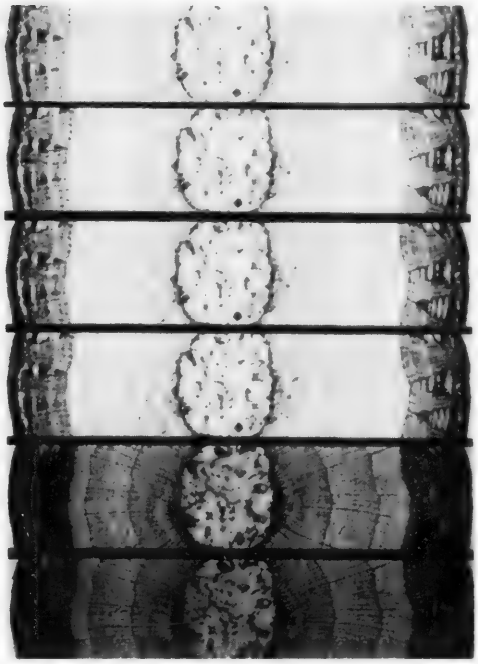

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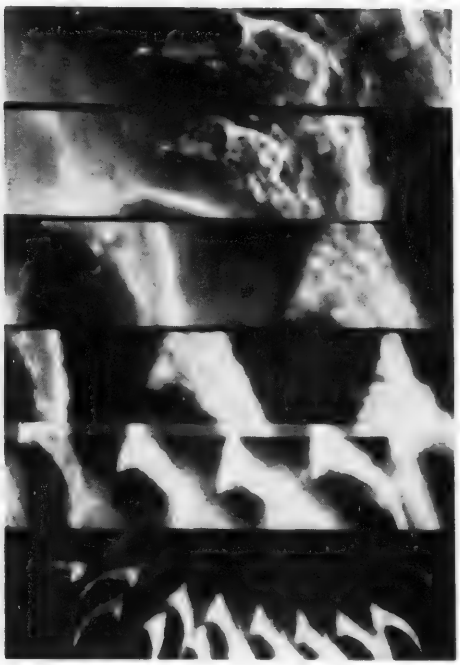

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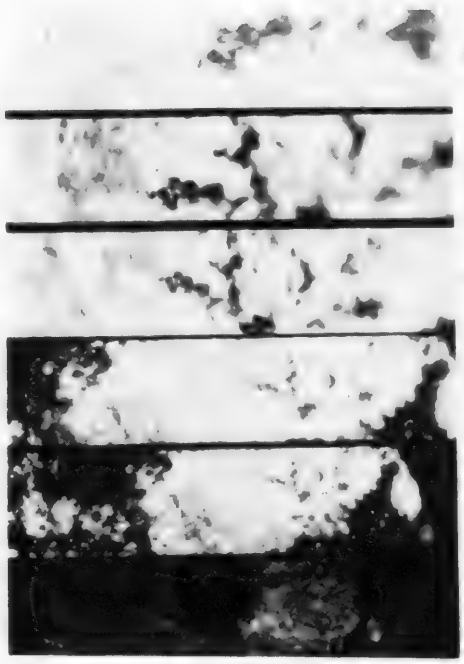

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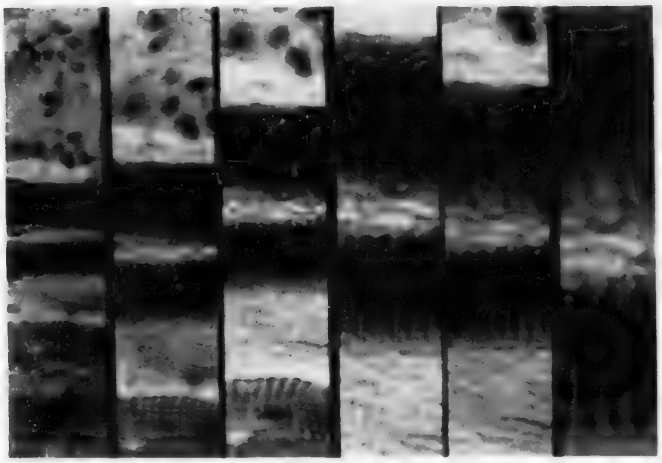

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REFERENCES

1933 Gross and Johnson: Photoelectric Exposure Meter for Photomicrography, J.B.P.A., 1, 172-192.

1934 Henbest, L. G.; Exposure Determination in Photomicrography, J.B.P.A., 3, 2-23.

1936 Wieland, M.: Ein Messverfahren zur Bestimmung der Belichtungszeit fuer die mikrophotographische Aufnahme, Z. wiss. Microskop. mikroskop. Tech., 53, 183-192.

1937 Weber, J.: Color Photomicrography, Leica Phot., 16, (Dec.).

1938 Graff, John H.: Determining Exposure Time of Photomicrographs with the Instoscope Exposure Meter, J.B.P.A., 6, 161-171.

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1940 Michel, Kurt: Grundzuge der Mikrophotographie, Zeiss-Nachr. Sonderh., 4.

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1943 Michel, Kurt: Handbuch der Wissenschaftlichen und Angewandten Photographie, Ergaenzungswerk, Springer-Verlag, Vienna.

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1952 Neubecker, Robert D.: A Simplified Technic for Taking 35mm Color Photomicrographs, U.S. Armed Forces Med. Jour., 3, 1055-1060.

Amaryllis

The KODAK EKTALITH PROCESS

A descriptive outline of a new, low-cost, color reproduction process, based on the publications of Dr. Walter Clark and Dr. H. C. Staehle of the Kodak Research Laboratories, Rochester, New York. The process has not been announced generally, having been presented only to specialized graphic arts circles and to certain other technical groups. Reference sources are given on page 36. The editor gratefully acknowledges the cooperation of the Kodak Research Laboratories in granting permission to publish this review and in supplying the color illustrations for tipping-in on this page and on page 36. The responsibility for the accuracy of the review rests solely with the editor.

THE *Kodak Ektalith Process* is rather well characterized in the titles of two of the papers listed on the following page by Dr. Walter Clark and Dr. H. C. Staehle, namely, "Experimental Low-cost, Short-run Colour Printing" and "A Simplified System of Color Printing". However, it appears now that the process has progressed beyond the experimental stage, even though it has yet to be released for commercial application.

The process has been developed with the view of satisfying the need for a color reproduction system that would permit a more widespread use of color illustrations in scientific books, monographs, technical periodicals, and a variety of publications of learned societies. With present color reproduction methods the costs are prohibitive for general purposes in printing runs of a few hundred to 5000 or so. The exact extent to which the *Kodak Ektalith Process* will reduce color printing costs for short-runs is not known, but everything seems to point toward a very significant reduction.

Similarities of Process to Conventional Offset Color Lithography

In a very broad sense the *Ektalith Process* is related to conventional methods of offset color lithography. That is, there are three main steps, as follows:

1) the preparation of screen-separation negatives.
2) the preparation of printing plates.
3) the offset lithographic printing.

In a step-by-step comparison of the techniques involved in carrying out these main steps, it becomes evident that the *Ektalith Process* departs widely from conventional lithographic methods. Nevertheless, the departures are not of a fundamental nature, because they could be applied to conventional lithographic color printing.

Dissimilarities to Conventional Methods

The *Ektalith Process* departs from conventional lithographic color printing procedures in the following ways:

1) All color correction is achieved photographically.
2) Printing is done in three colors instead of four.
3) All the printing is done with 266 line halftones.
4) Printing is done using *Kodak Ektalith* printing plates.
5) The printing is done on Multigraph Duplicators.
6) All registration is done by mechanical means.
7) The method is worked out primarily for making reproductions from 35mm Kodachrome transparencies.

The total system incorporating these various departures is the result of five years of research and development to which many individuals have made substantial contributions. The offset lithographic method of printing was chosen because the *Kodak Ektalith Sheet*, a product intended for the general lithographic trade, was under development at the same time as the new color printing system, and it seemed to fit the criteria established for a low-cost color printing method.

Ektalith Sheet

The *Kodak Ektalith Sheet* has a thin metal support, coated with a layer of a surfaced-hydrolyzed cellulose ester. A solution of ammonium bichromate is used for sensitizing the plate. After exposure

Natural Hybrid Pitcher Plant

REFERENCE SOURCES

Clark, Walter	Cellulose Acetate Offset Printing Plate, Proceedings of the 2nd Annual Meeting, Technical Association of the Lithographic Industry (April 24, 1950), 115-118 (1951).
	Experimental Low-cost, Short-run Colour Printing, Penrose Annual, 46, 125-127 (1952).
Staehle, H. C.	A Simplified System of Color Printing, Proceedings of the 4th Annual Technical Meeting, May 6, 1952, TAGA, 143-150, (1952).

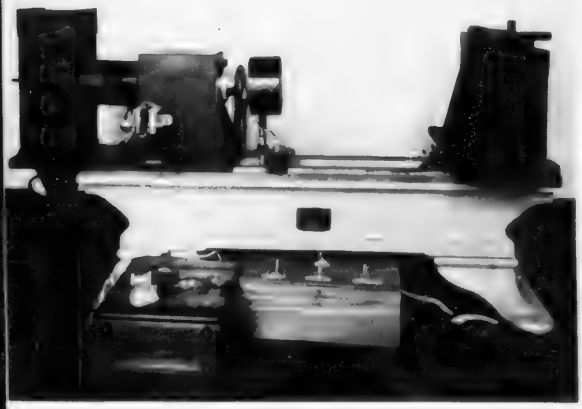

Figure 1

to a line or halftone negative the plate is processed by a swabbing technique for about three minutes to remove the hydrolyzed layer in those areas that will pick up ink in the final printing operation.

Description of Process

First, it should be emphasized that the process has been designed particularly for reproductions from 35mm color transparencies. By concentrating on this size of original, the process was greatly simplified because the step-by-step operations could be standardized.

The 35mm color transparency is masked before the screen-separation negatives are made. A 40% masking negative is prepared, using pre-punched panchromatic masking film that fits a registering holder. The transparency is placed in a cut-out opening in a sheet of pre-punched cellulose acetate for the contact exposure.

Screen-separation negatives are next made directly from the masked original in an especially designed camera (Figure 1). A 266 line neutral halftone contact screen is employed, and the blue, green, and red separations are exposed onto a single sheet of *Kodalith Pan Film*. The three exposures onto one film is made possible by a sliding vacuum film holder (Figure 2).

A very efficient light source and optical system is incorporated in the camera so that the exposure times for the screen-separations are of the order of 10 seconds, 20 seconds and 100 seconds, respectively, for the No. 25, No. 61 and No. 47B filter exposures.

Development of the separations is done by tray, the developer temperature being critically controlled. When the processing is completed the three negatives are cut from the film for the plate exposures.

A pin-register holder for the separation negatives and *Ektalith Sheet* has been designed as a part of a vacuum printing frame (Figure 3). The separation negatives from two 35mm color originals are paired so that the plate exposures for two subjects can be made

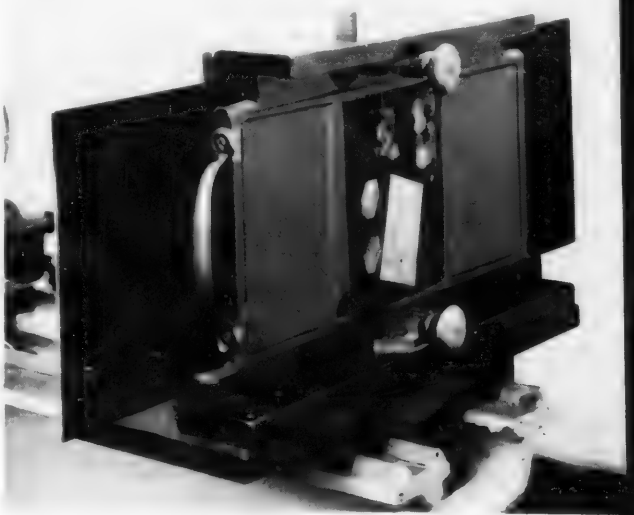

Figure 2

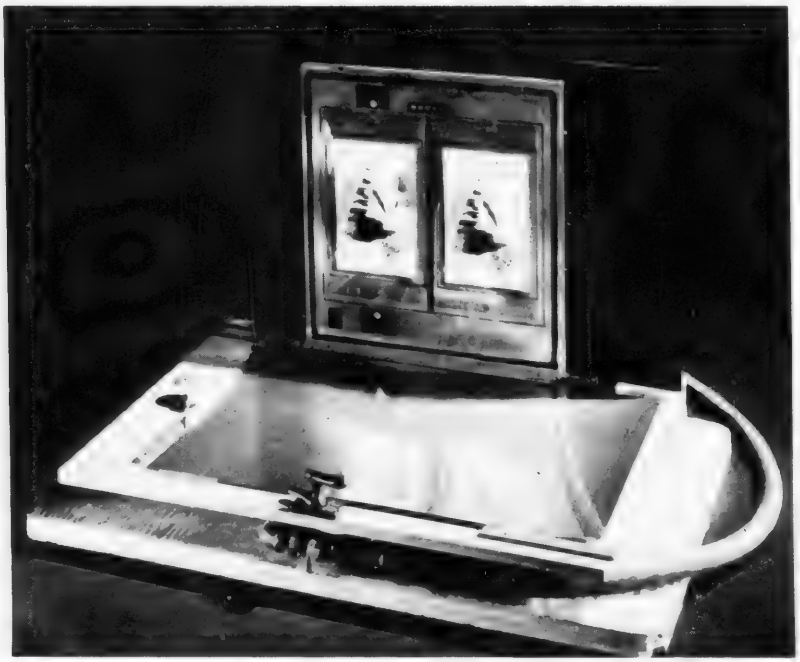

Figure 3

simultaneously. That is, the two blue, the two green, and the two red separations are exposed together. Using a 30-ampere arc, the plate exposure time is approximately 45 seconds.

A slightly modified *Model 1250 Multigraph Duplicator*, an office machine, was used for printing the color illustrations for this review. Hundreds of subjects have been printed with such machines during the experimental work, and runs up to 16,000 impressions have been successfully accomplished.

Only three inks are required, the usual black printer being eliminated by careful choice of inks and by applying the inks in greater than customary amounts during the printing operation.

Quality of Reproduction

The inherent quality of reproduction obtainable with the process is excellent. It is the result of a number of factors working in combination. The definition, for example, is derived from,

1) the perfection of the optical system designed for the screen-separation camera.
2) the use of a ring-shaped light source for the masking exposure which gives a somewhat unsharp mask image.
3) the use of a 266 line halftone screen.
4) the smooth, grainless surface of the *Ektalith* printing plate.
5) the choice of inks.

The good color saturation and better than average tone reproduction also result from several factors, including the use of a strong mask, the printing qualities of the plate, the use of a contact screen, etc. Registration throughout the entire process by mechanical means contributes to good quality consistency.

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Photographic Guns*

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PHOTOGRAPHING of wild animals always requires special equipment. The miniature camera (24mm x 36mm) with a 13.5cm or 20cm objective (with or without reflex-housing) is used by most specialists. However, in photographing birds and small mammals a focus of 40cm or more has been found to be of great help. Fortunately, this optical equipment is expensive, heavy, and always requires the use of a strong stand. Therefore, I have solved the problem in the following way: In order to diminish the cost and the weight, I have employed achromatic objectives of the "Doublet" type (easily procured at low cost through "war surplus"). I have used in particular an American objective of 36cm focus (f/6.8) and a German lens of 44cm focus (f/5.9). Both proved to be excellent. The spherical aberration was very near zero, the chromatism negligible and the resolving power more than 100 lines per mm. The coverage, however, is not satisfactory at full opening, but improves with smaller apertures. The objectives are provided with an iris diaphragm and helicoidal mount.

To avoid the use of a heavy stand and to improve the manipulation of the camera, the objective was mounted on a stock, thus realizing a photographic gun (simi-

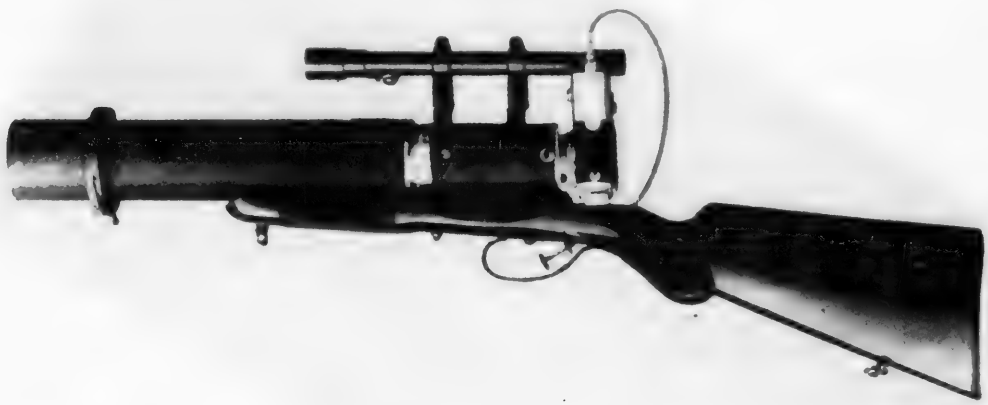

Figure 1. Author's Photographic Gun Equipped with Telescopic Sight.

* Received for publication April 25, 1953.

Sea-Gull in Flight. Shot at 40 yards with 44cm objective, f/6.8, 1/500 second, highly enlarged.

lar to the ones of *Kilfit* and *Rectaflex*).

A first model (Fig. 1) is equipped with a telescope sight (magnifying power 2X) and is focused by means of a graded scale. With a *Leica* camera, provided with a *Leica* motor, the arrangement is well adapted for the photographing of birds in flight.

A later model (Fig. 2) was built with a modern reflex housing (with erected image), the *Novoflex*, and is well fitted to general photographic usage. Both arrangements gave excellent results on birds in flight on distances of about 100 yards.

Young Woodcocks in Flight.

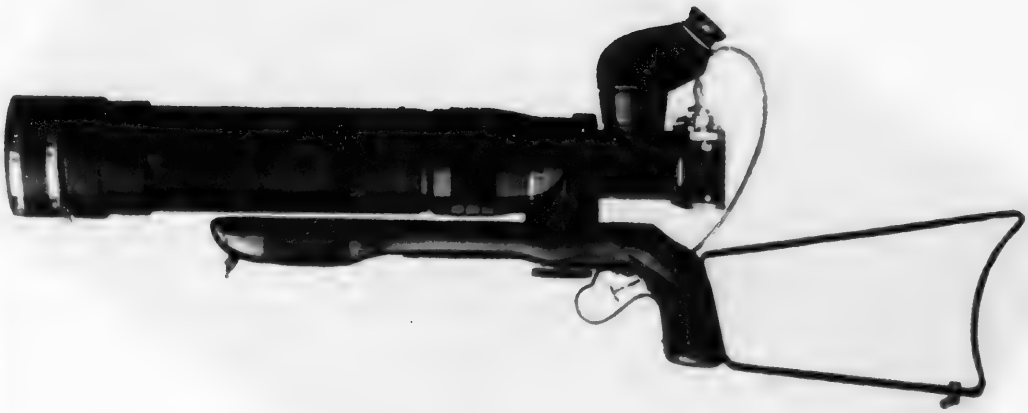

Figure 2. Author's Photographic Gun Equipped with a Modern Reflex Housing.

Shot at 120 yards with 44cm objective, f/6.8, 1/500 second.

THREE RELATED PAPERS ON COLOR FILM PROCESSING

Increasing the Speed of Color Film for High-Speed Flash Photography of the Ocular Fundus*

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Introduction

BLACK and white photography of the eye fundus was made routine by the introduction of the *Zeiss-Nordensen* retinal camera in 1926[1]. Black and white pictures can be made with this camera at shutter speeds of 1/10 to 1/25 second with a nitra filament lamp as the light source. Faster shutter speeds produce underexposed negatives. Shutter speeds of 1/10 to 1/25 second, however, are not rapid enough to prevent failures due to blinking or involuntary movements of the eye. Thus, the longer exposures necessary for color film have resulted in a high percentage of failures.

High-Speed Flash System

Jacobs and Ogle[2] have described the adaptation of a high-speed flash tube to the *Zeiss-Nordensen* camera. The duration of the flash is approximately 1/10,000 second, therefore, failures due to blinking or eye movements are

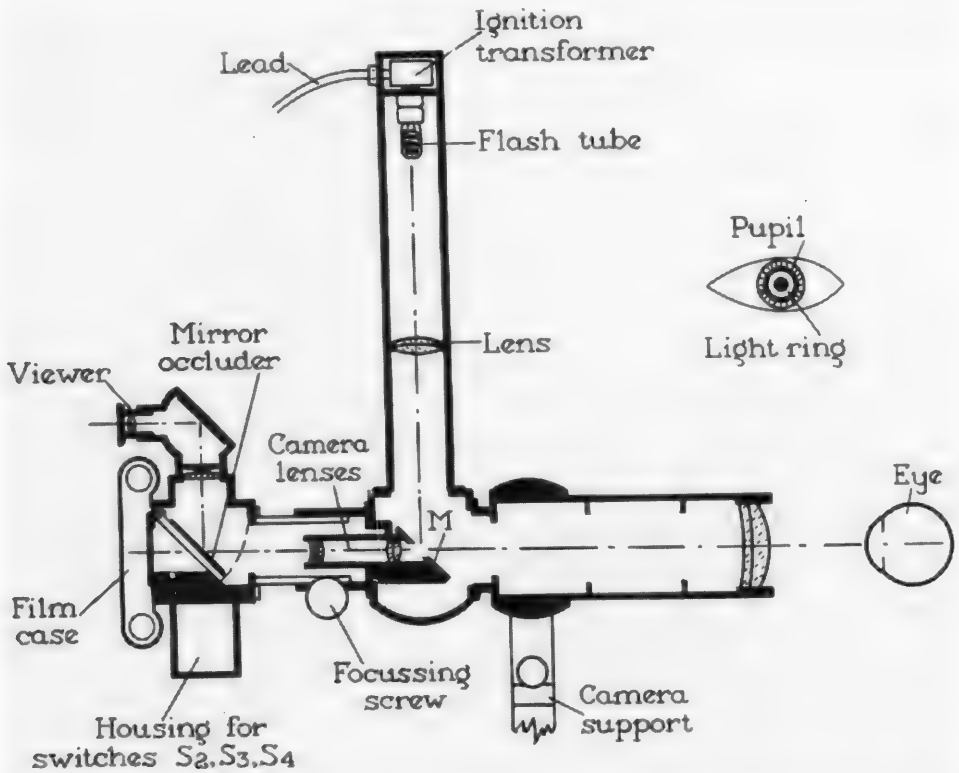

Figure 1. Flash Tube Assembly as Used in the Zeiss Retinal Camera by Jacobs and Ogle. Reprinted by permission from Jacobs, Martin and Ogle, K. N., Applications of High Speed Flash Tube to Photographing the Fundus of the Eye in Color. Rev. Scient. Instruments. 24:52-55 (Jan.) 1953.

* Received for publication April 13, 1953.

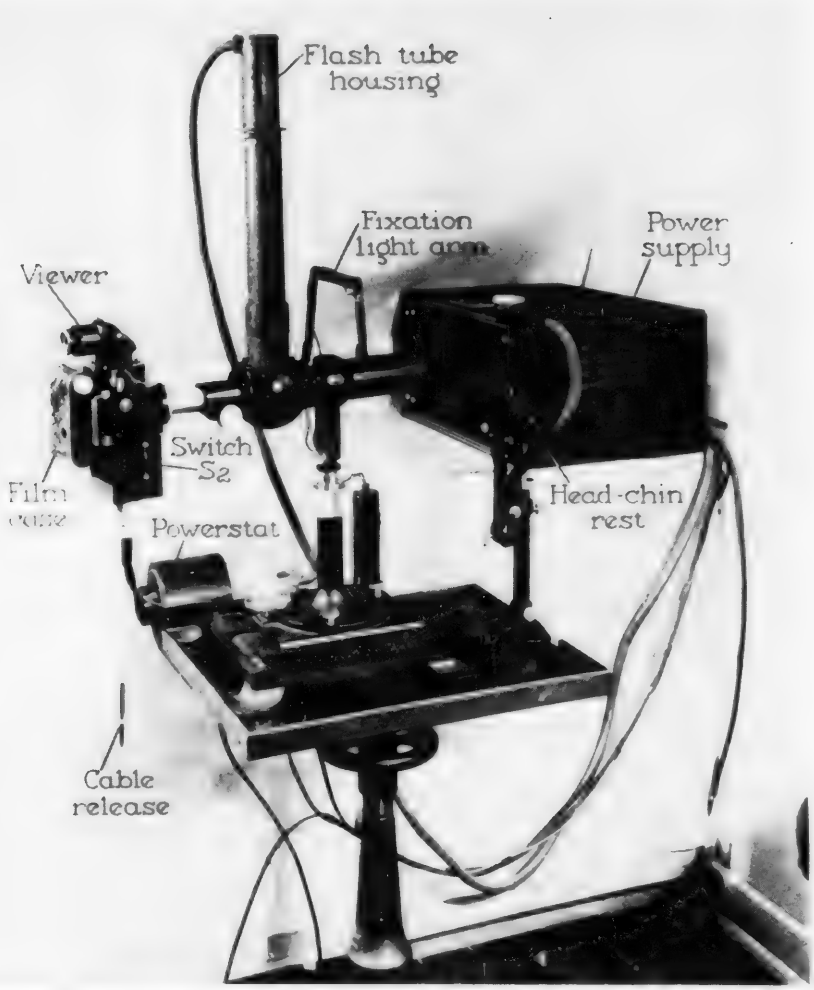

Figure 2. The Zeiss Retinal Camera with Flash Tube Assembly. Reprinted by permission from Jacobs and Ogle. See legend under Figure 1.

practically nonexistent. An *Amglo* 68R9M *Flash Tube* is used (Fig. 1).

Light for focusing is also provided by the flash tube. For this purpose the tube flashes approximately thirty to fifty times per second, but at an intensity lower than that used for film exposure. This light is not disturbing to the patient, yet it is sufficient for focusing and viewing. When the focusing light is turned off, the exposure flash is actuated by a special switch mounted below the film carrier (Fig. 2). This is done in one operation by the operator who presses the cable release (Fig. 3). A separate switch turns on the focusing light.

The high-speed flash underexposes *Ektachrome* film by approximately two stops when the film is processed normally (Fig. 4b). It had been reported, however, that the speed of a reversal color film is increased without serious changes in color reproduction by overdevelopment in the first developer[3,4,5]. Before attempting to adapt this technic to photography of the ocular fundus, controlled tests were made on *Ektachrome* sheet film to determine the effect of overdevelopment on the speed of the film and on the color balance.

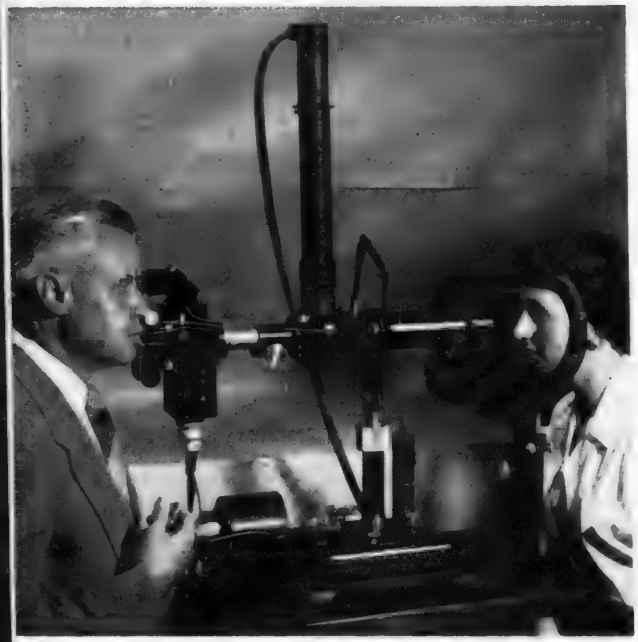

Figure 3. The Zeiss Retinal Camera Showing Operator and Patient.

Figure 4b. A Black and White Reproduction of an Ektachrome Color Photograph Processed Normally.

Figure 4a. The Same Fundus Field Photograph Processed for Two and a Half Times the Normal Time in the First Developer.

The test exposures were made of standard color charts using recommended illumination. The exposure was varied by changing the lens diaphragm stop. Thus, by keeping the shutter speed constant, effects of reciprocity law failure were avoided. Separate exposures were then processed, with first developing times ranging from the normal of 10 minutes to 45 minutes.

Test Results

These tests confirmed previous statements that the speed of *Ektachrome* film is increased when the first development time is increased. For practical purposes the same overall density of the transparency was obtained when the exposure was decreased by one stop and the first development time was doubled. For example, a transparency given an exposure of 1 second at f/22 and developed 20 minutes in the first developer compared favorably with a transparency correctly exposed for 1 second at f/16 and developed for 10 minutes in the first developer. Overdevelopment of 30 minutes or more did not prove satisfactory. The additional first developing time caused serious color changes, an excessive increase in magenta and an equally undesirable loss of yellow.

Conclusion

Photographs of the fundus of the eye have proved satisfactory when made on daylight type *Ektachrome* film and procesesd 25 minutes in the first developer (Fig. 4a). Since the fundus of the eye is chiefly reddish, the increase in magenta due to overdevelopment has not proved detrimental. The increase in film speed has materially aided in production of satisfactory color pictures of the ocular fundus. This technic cannot be recommended for color transparencies of greatest possible accuracy but color compensating filters can be used to obtain generally satisfactory color balance.

References

1. Koch, F.L.P., Color Photography of the Human Ocular Fundus: Its Technic with the Zeiss-Nordensen Retinal Camera, J. Biol. Photo. Assoc., 9:119-135, March (1941).
2. Jacobs, Martin and Ogle, K.N., Application of High-Speed Flash Tube to Photographing the Fundus of the Eye in Color, Rev. Scient. Instruments, 24:52-55, Jan. (1953).
3. Brewer, E. F., How to Speed Up Ansco Color Film, Modern Photography, 16:42, Jan. (1952).
4. Crandall, R. S. and Lavelle, Michael, Improved Ektachrome — How to Use It, Popular Photography, Vol. 29, July (1951).
5. Goldsmith, A. A. Jr., Eyerman Reveals Life's Secret Process for Speeding Up Ektachrome, Photography, 32:50-51 and 206-209, May (1953).

Rapid Exposures In Color Photomicrography*

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Introduction

IN photomicrography with color film, normal exposure does not always yield the best results. This is true when photographing biological specimens treated with such stains as hematoxylin and eosin, fuchsin, and others that have narrow spectral transmittance bands where the color sensitivities of the emulsion layers of the film overlap. Excellent photomicrographs of biological specimens, treated with these stains, have been made with *Type B Ektachrome* film by reducing the exposure to 1/10th normal and altering the recommended processing times for the first developer, the color developer and the bleach.

Illustrations

Figures A through D are black and white reproductions of photomicrographs made with *Type B Ektachrome* film using (1) normal exposures with normal development (2) reduced exposures with increased development. This specimen is a skin section taken from a patient with chronic dermatitis, stained with hematoxylin and eosin. In each instance a 6 volt, 18 ampere ribbon filament lamp was used.

The original photomicrographs of A and B were made at 60X, using a 16mm apochromatic objective with a 5X *Ampliplan* ocular. The exposures were one second for A and 1/10 second for B.

The original photomicrographs of C and D were made at 240X, using a 4mm, 0.95 apochromatic objective with a 6X *Ampliplan* ocular. The exposures were three seconds for C and 1/3 second for D.

Procedure

The illumination must have a predominance of green to correct for the increase of magenta resulting from increased first development. In photographing the examples shown, the 2800 K color temperature of the ribbon filament lamp was adjusted by introducing correction filters CC-20C (cyan) and CC-20Y (yellow) to achieve the desired predominance of green. The particular filter combination will depend upon the characteristics of the film used. Since *Ektachrome* film often differs from emulsion to emulsion, it is best to test each new emulsion to determine the direction and extent of the color shift.

In determining the exposure time, an ASA index of 100 for *Type B Ektachrome* is used instead of the rated index of 10. The author uses the Koehler principle of adjusting the illumination system to bring the image of the lamp filament to a sharp focus on the closed

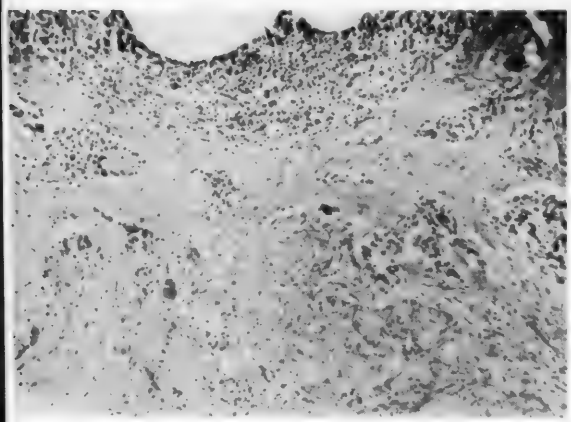

Figure A. See Text for Explanation.

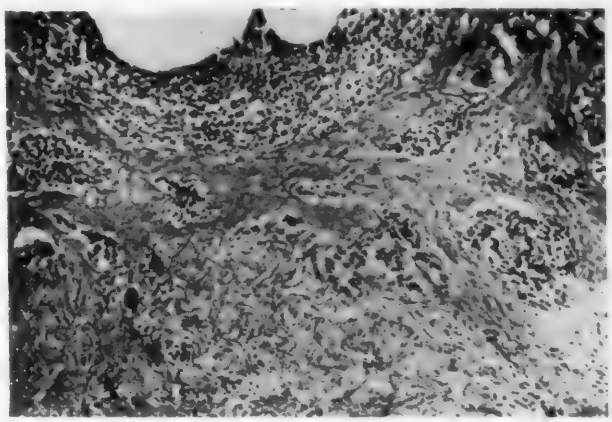

Figure B. See Text for Explanation.

* Received for publication March 30, 1953.

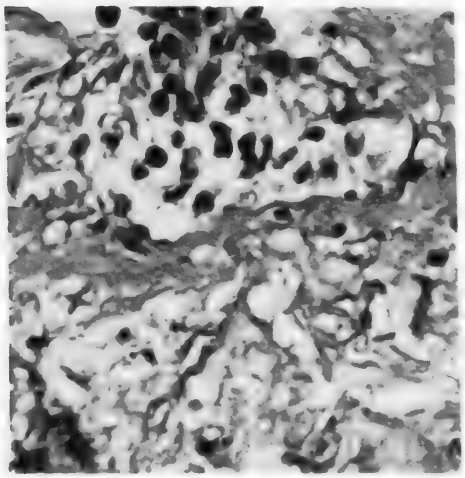

Figure C. See Text for Explanation.

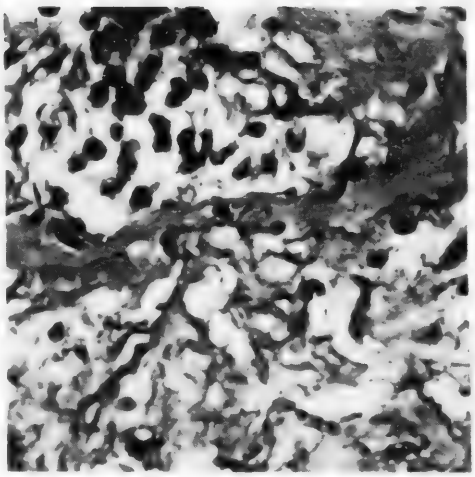

Figure D. See Text for Explanation.

substage iris diaphragm. The microscope condenser is then moved up or down to bring the iris diaphragm of the light source to a sharp focus in the plane of the specimen, and thus in the focal plane of the camera. The iris diaphragm of the source then acts as a field aperture which controls the size of the illuminated field without changing the illumination in the field, whereas the substage diaphragm controls the illumination without changing the size of the field. The search unit of a *Photo-Volt 200M Meter* is used by the author for light measurement. It is placed on the ground glass, and readings are made from the brightest area of each focused slide.

Processing

The exposed *Ektachrome* film is processed in solutions at 75 F. Agitation consists of draining the film from alternate corners for 5 seconds every 2 minutes.

The first developing time is 27 minutes instead of the recommended 10 minutes. Film is then washed, hardened and second exposed in the usual manner.

Increasing the developing time in the first developer increases the effective emulsion speed, increases highlight contrast and causes an increase of magenta and a decrease of yellow.

After a 3 minute wash following the reversal exposure the film is placed in the color developer for 7½ minutes. By decreasing the time in the color developer, the highlight contrast built up in the first developer is not so effective in giving an impression of overall contrast increase. The shadow contrast is weakened by reduced color development, resulting in an apparently normal contrast in the transparency. The decreased color development also shifts the color balance toward green which, in combination with the color adjusted light source, acts as a corrective for the increase in the magenta due to increased first development.

The bleaching time is increased to 15 minutes. This change plus the processing variations in first and color development represent the only deviations from the manufacturer's recommendations.

Summary

1) A technique is described for improving the quality of photomicrographs made on Ektachrome Type B film. It consists in a reduction of exposure to 1/10 that of normal, and altering the illumination and processing.

2) The technique is especially applicable in obtaining more satisfactory color rendering in photomicrographs of biological specimens where stains such as hematoxylin and eosin, fuchsin, and others with narrow spectral transmittance bands are used.

3) The technique is useful where short exposure times and low light intensities are necessary.

High Contrast Color Photomicrography*

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Introduction

"ONE of the most important factors in photomicrography is the contrast, or the brightness differences, in the image and also in the corresponding tones of the photograph. The contrast within the different specimens themselves varies greatly, as does the contrast between the structures to be shown and its background. Therefore, the problem usually resolves itself into the rendering of increased or diminished contrast."

The foregoing is quoted from the *Kodak Industrial Data Book, Photography Through The Microscope*. The truth of the statement is, or should be, evident to the photomicrographer who has worked with black and white materials.

Although the problems are frequently quite similar, the need for controlling contrast in color photomicrography generally has not been felt. However, the problem often does arise of photographing in color specimens with inherently low contrast characteristics. A brief review of the means for increasing contrast in color photomicrography may be of help to those not already familiar with them.

Optical Control

Additional contrast may be obtained by adjusting the condenser or substage diaphragm so that a narrower cone of illumination is used. Nevertheless, deviations from the optical criteria of Koehler, or other forms of critical illumination, will result in a loss of resolution and, if carried to extremes, will cause diffraction with a subsequent degradation of the entire image.

Control Through Exposure

An effective means of controlling color saturation — not contrast — is through exposure variations. Underexposure, whereas giving greater color saturation to the field, will also give the clear areas a muddy appearance. Though this technique is being used by some as an additional means of inching toward more usable results, it is a technique which certainly needs improvement. Slight overexposure, having the effect of causing colors to become pastel, is a usable means of decreasing contrast, if not carried to extremes.

Control by Filters

Color filters may not be used in color photography to decided advantage as in black and white photography for controlling contrast. Their value in controlling contrast with color films generally is negligible, but it has been stated that successive exposures through narrow band blue, green and red filters enhances the contrast of a color film. Such an exposure system is not considered practical for routine purposes.

Control In Processing

The processing of color films usually requires adhering strictly to the processing directions. Some exceptions to this have been made by the manufacturers. When copying color originals with *Ektachrome* film, *Eastman Kodak* recommends a 30% increase in first development time to obtain increased contrast. When using this method, *Kodak* recommends that the normal exposure be decreased one-half f/stop and that the CC-10G filter be used to compensate for a shift toward magenta in the color balance. One laboratory known to the writer has been using approximately the same method to compensate for the flatness of electronic flash lighting. No doubt there are many others. *Ansco* has made similar recommendations for their color films.

High Contrast Development

Having recognized the need for additional contrast and the possible means of obtaining it, tests were conducted at progressively higher first development times until a point of practical maximum contrast was reached. This proved to be a 20 minutes first development time. The contrast was excellent as compared to the normally processed film, and there were no difficulties experienced with staining or fogging. The color balance shifted toward the red, and an attempt was made to correct this with an *Eastman Kodak* CC-10G filter. The color balance then shifted toward yellow. Additional tests showed that a CC-10B filter in addition to the CC-10G filter, gave very satisfactory neutral reproduction. It was necessary, of course, to reduce the exposure to compensate for the change in speed characteristics of the film, amounting to about one full lens stop decrease, i.e., the film developed normally

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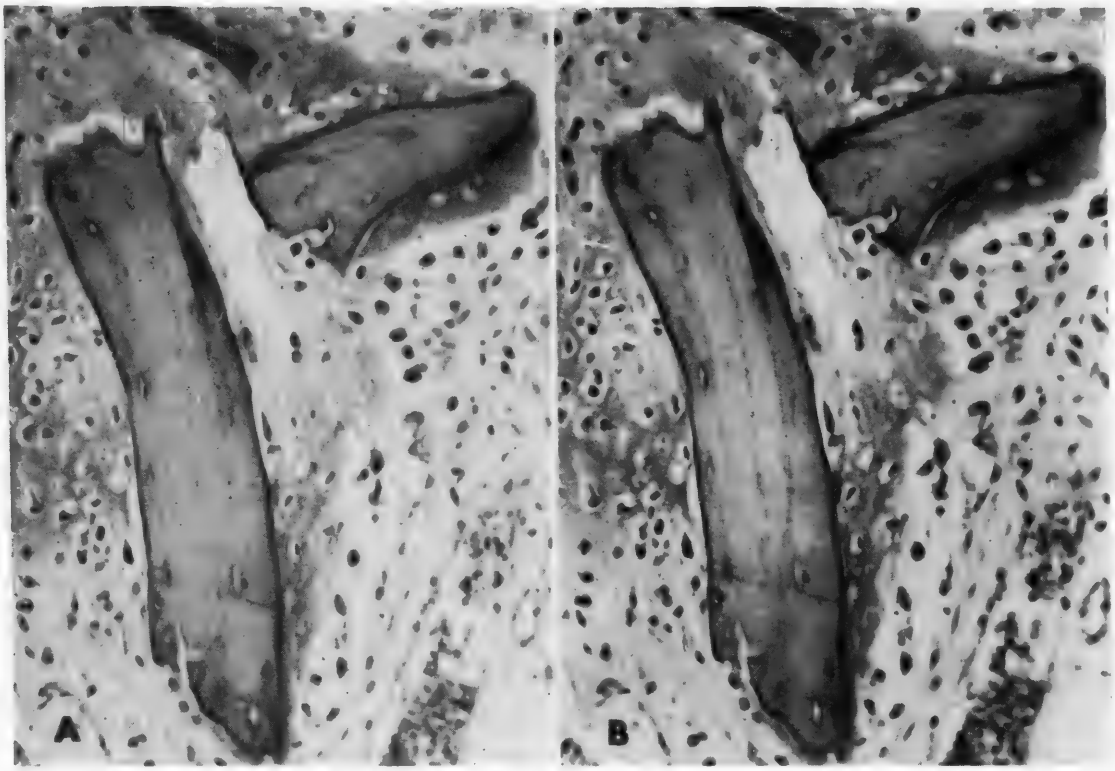

Figure 1. The Above Are Reproductions of Two Ektachrome Transparencies. "A" Was Normally Exposed and Normally Processed, i.e., 10 Minutes First Development. "B" Was Given One-Half Normal Exposure, using CC-10G Plus CC-10B Eastman Filters, and Processed for High Contrast, i.e., 20 Minutes First Development.

received an exposure of 1/5 second, whereas film receiving 20 minutes first development was exposed at 1/10 second, using the CC-10B plus CC-10G filter combination. A comparison of results is shown in black and white in Figure 1 (A and B).

A possibly helpful suggestion with regard to processing high contrast and normal contrast films together is to immerse the films for high contrast first and, after the given time difference has elapsed, place the normal contrast films in the first developer and continue processing both groups as usual.

Summary

1) Additional contrast is often necessary when taking photomicrographs in color.
2) Additional contrast may be obtained by increasing the first development time of reversal color films.
3) It is necessary to decrease the exposure and to use the proper filter or filters to compensate for the shift in color balance.

Below is a table of recommended trial exposure, filter and first development requirements for *Ektachrome* film.

	Filter	Exposure Decrease	First Development — 75 F.
Normal contrast	none	none	10 minutes
+ contrast	CC-10G	½ stop	13 minutes
++ contrast	CC-10G plus CC-05B	¾ stop	17 minutes
Maximum contrast	CC-10G plus CC-10B	1 stop	20 minutes

The Photographic Society of America*

DON BENNETT
Editor, PSA Journal

(This is the second in a series of invited papers on leading photographic organizations.)

THE P.S.A. performs a valuable function in the overall activities of photography in America. Although its interests to some extent overlap those of other American photographic organizations — the Society of Motion Picture and Television Engineers, the Society of Photographic Engineers, the Biological Photographic Association, etc. — the bulk of its activities are unique.

The uniqueness of P.S.A. derives from the large number of members who are amateur photographers. Because of this heavily weighted amateur membership, it often appears as though P.S.A. is nothing more than an organization for amateur photographers. Although it is true that the present society is an outgrowth of an amalgamation of camera clubs, its membership structure and purposes have greatly broadened through the years. In its beginnings it was thought by the participating camera clubs that a group organization could provide services which no one club was able to provide on its own. Today, however, it is the individual member of P.S.A. who is the principal recipient of the Society's services, even though camera club services have continued and expanded in many ways.

The *Society* holds an Annual Convention, during which all of its Divisions have separate programs consisting of formal papers, demonstrations and provocative open discussions. In order to correlate the diverse interest of the various Divisions, certain parts of the Annual Convention program are planned so that all Division members can meet as one body.

In addition to the annual convention, numerous regional meetings are held through each year. A special annual event sponsored by the *Society* is called TOPS IN PHOTOGRAPHY, and recently a new form of activity has begun which is called the TOWN MEETING. The *Tops In Photography* shows and the *Town Meeting* often have a single focal point, such as movies, but the primary aim always is to stimulate photographic interest.

The special interests of society members are served through the divisional structure of the organization. The *Pictorial Division* is the oldest of these specialized groups, and it serves salon exhibitors and camera clubs. There are six additional divisions of lesser membership than the *Pictorial Division*, but not less in importance. These divisions are the,

Color Division
Nature Division
Motion Picture Division
Technical Division
Photo-Journalism Division
Stereo Division

It is not necessary for membership in the national organization for a person to be affiliated with a particular division. Nor is a member restricted to only one division.

The *Society* publishes a monthly journal which serves the interests of all members and divisions except the special interests of the *Technical Division*. The *Technical Division* publishes a quarterly supplement to the PSA *Journal* in which appears some of the most noteworthy papers to be found in any photographic publication on photographic science and technique. As a matter of fact, this supplement has as its name *Photographic Science and Technique*.

The membership of the *Technical Division* includes the names of many leading photographic scientists and technicians. Numerous members of the *Biological Photographic Association* are represented. It is perhaps at this level that the two organizations have their most common meeting ground. On the other hand, B.P.A. members are also leaders in other divisions of P.S.A., such as the *Motion Picture Division* and *Nature Division*.

The *Society* has its own permanent headquarters at 2005 Walnut Street, Philadelphia 3, Pa. Several full time staff members carry out the routine activities of the organization. The headquarters building also houses the SOCIETY LIBRARY, and the HISTORICAL AND PERMANENT COLLECTION.

For outstanding achievements in all phases of photography, the *Society* elevates active members to ASSOCIATE MEMBERSHIP, FELLOWSHIP MEMBERSHIP or HONORARY MEMBERSHIP upon the recommendation of the *Honors Award Committee*. Awards are also presented, such as PROGRESS MEDAL AWARD, SERVICE AWARDS, STUYVESANT PEABODY AWARD, and SPECIAL AWARDS.

* Based on paper presented at the 22nd Annual Meeting, N.Y.C., 1952.

Biological Photographic Association and Its Journal*

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AT the beginning of this 22nd Annual Meeting, a brief review of the history of our Association and its Journal may provide a bit of enlightenment for our new members, and for our older members, a measure of nostalgic pleasure.

Prior to the formation of the Biological Photographic Association, photographers in the fields of medicine and biology had practically no contact with others in the same fields, did not know who or where other photographers were or how they worked. Photographs by biological photographers were seen in publications but without credit lines, and so the makers remained anonymous. In some areas of concentrated population this condition existed to a lesser degree, but even in these instances the workers felt the need of an organization.

As a result of preliminary arrangements, an organizational meeting was held on September 11, 1931, at New Haven, Connecticut. At that meeting a group of 28 persons from 7 eastern states banded together into a permanent organization known as the "Biological Photographic Association."

In the words of its constitution, "The object of this Association shall be to further the study of photography in relation to the biologic sciences, and improve its technic." Furthermore, its first president declared, "This Association must remain unselfish in its aims. It is by no means a professional union organized to set price standards, or to dictate in any way to its members. Its purpose must be to help and stimulate its members and to endeavor to establish certain standards of quality."

In addition to the drawing up of a constitution and by-laws, and election of officers and directors, there was the customary work of establishing an office of operations, ordering stationery and planning future activities.

The original plan was simple: it provided for an annual meeting in September and a spring meeting, and then perhaps the distribution of mimeographed reports of the papers given and proceedings at the meeting. A widespread membership was not expected. Articles written by members could be published in one of a number of photographic journals.

However, a few months after the organizational meeting, the Board of Directors discussed the advisability of publishing a journal. It was thought that the entire cost of a small quarterly journal could be covered by receipts from advertising and subscriptions, and from part of the first year's dues of those members who joined as a result of the journal publicity.

The Association had no money for the purpose but one of the members offered to publish a journal as a business venture. On this basis he had the first two issues printed by a commercial printer. Excess back numbers of these two issues were accepted as payment for the third issue which was printed by a second printer. This printer then took over publication of the Journal and, beginning with the fourth issue, financed its publication under the terms of a contract signed by the Association.

Although the Association had not signed an agreement with the member who published the first two issues at a loss, it was considered a debt of honor. The Association had benefited greatly by having a journal, and several years later when funds were available, this debt was paid.

The contract with the new printing firm specified that they were to publish the Journal for five years, at the end of which time they could discontinue if it was being published at a loss. Profits would be shared equally between the Association and the publisher, but even if there were no profits, the Association was assured of a Journal for five years.

Due to the economic depression, advertising space was difficult to sell, and many members were laid off or had salaries reduced and failed to pay their dues. It was not unexpected, therefore, when the publisher decided to discontinue publication of the Journal, at the end of Volume 6. At that time also, the editor of the first six volumes resigned because of other duties.

* Presented at the 22nd Annual Meeting, N.Y.C., 1952.

A special open meeting of the Directors was held in September, 1937, to discuss the Journal situation. After various courses of action were considered, a Committee on Journal Publication was appointed and, in April, 1938, arrangements were made with another firm to take charge of publication for a period of five years. A committee of members edited the September 1938 number of the Journal, after which a new editor assumed the task.

For unavoidable reasons, the contract with the publisher was discontinued at the end of the first year. Up to this time the Association had been in a sort of partnership with its several publishers but this arrangement did not work out to the satisfaction of any of the parties concerned. Now the Association became owner of the back numbers of the Journal, and the editor assumed the business management in addition to his other duties. There was a gratifying demand for back numbers and it became profitable to reprint several numbers in order to provide complete sets for sale.

The Journal continued on this basis for ten years until the editor asked to be relieved after he had completed Volume 17. His resignation was accepted with regret. His successor found it necessary to resign one year later because of a new position which precluded his continuing as editor. One of the officers then agreed to serve as editor through 1952.

Although the affairs of the Journal occupied much of their time, the Directors had many other matters to consider. The financial problem was ever present and, although no officer or director receives any pay or allowances, some payment was made for clerical help. The editors have served without payment for their services.

One of the earliest problems pertained to membership. Should it be restricted to professional photographers or should any interested person be permitted to join? Should there be various classifications of membership and what should be the dues? In general, it was decided to be liberal in accepting applications for membership and to keep the dues at a low level.

At that time, intensive membership drives seemed of doubtful value. Every new member meant added income but if he was not especially interested he might allow his membership to lapse. He would receive one additional copy of the Journal before his name was removed from the list and this, together with follow-up letters and postage, reduced working funds. Throughout the years, however, membership has increased slowly and steadily; the contributing memberships and sustaining memberships have been especially helpful. The advisability of changing the name of the Biological Photographic Association has been considered on a number of occasions. It was thought that the word "Biological" limited our field of activity, and that a change in the name of the Association and of the Journal would extend our usefulness and increase our membership.

Necessitating a great deal of planning and preparation, the annual meeting is the highlight of the year's activity. These meetings have been held each year although, during World War II, this was possible only through a number of last-minute changes in our plans.

At the 1934 Annual Meeting the Association staged its first competitive print exhibit and had the first commercial exhibit for which rental of space was charged.

The Association also prepared exhibits for display at meetings of various medical societies and of the Photographic Society of America. Traveling salons and albums also were prepared for loan to members.

Several organizations, including the Photographer's Association of America and the Photographic Society of America, invited us to merge with them. Publishers of several photographic magazines suggested that we combine our publications. While this would have eased the financial load, the Association would have lost its identity and freedom of action, so these offers were rejected.

For several years the Directors endeavored to have the Association incorporated but the technical requirements in various states and the costs proved a barrier until a friendly manufacturer of optical goods loaned the services of its legal staff in 1938. The principal reason for incorporation is that it protects the member, as an individual, from responsibility for the acts of the Association as a group. Moreover, it frees him from the danger of being sued for the Association's debts.

As the membership increased, it became desirable to establish chapters for the benefit of those members who could not attend the

annual meetings or who wished to meet more frequently. After considerable study and the establishment of rules, such activity was authorized.

About 1943 a number of members asked for the creation of an advanced rating of membership. This subject was given prolonged study and finally, in 1946, the first Fellows were named.

Arrangements made in 1948 provided for the Annual Award which is given to a person for achievement and contributions to biological photography and service to the Association.

In 1950 the Board voted to give an award for the best paper in each volume of the Journal and for the best paper presented at the annual meeting.

Much of the work of the Association is done by committees; the Motion Picture Committee probably has the longest record of service. Other committees, such as the Salon Committee and the Chapters Committee, can expect an increasing amount of work as the society grows. There have been many special committees appointed to deal with specific problems and, while they have had a short life, their actions have been of vital importance to the Association.

In this brief summary of the history of the Biological Photographic Association, many details have been omitted for lack of time. The greatest omission is the mention of names of the many *persons* who have worked long and hard in building the Association and its Journal to what it is today. In like manner it is *persons* who will build in the future. It is for you to be those persons and to supply the names — *your* names.

MEDICAL AND BIOLOGICAL ILLUSTRATION

Volume III — No. 1 January 1953

CONTENTS

Post-mortem Examination of the Coronary Arteries, Deryk Snow and Robert Ollerenshaw
Botanical Illustration, Stella Ross-Craig
Mounting: Part I, The Mount and the Original, Sylvia Treadgold
Photography in Plant Pest and Disease Control, C. M. Cadwallader
Some Characteristics of Effective Teaching Films, L. P. Greenhill and C. R. Carpenter
Equipment and Methods:
The E. E. L. Colour Temperature Meter
The Ilford "Skyhook" Lighting Set
An Aid to Sketching
Emulsion Stripping
A Versatile Illuminator
A Warm Stage for the Microscope
Tracing Film
Abstracts
Book Reviews
Motion Pictures
Reports from Societies

Annual Subscription (U.S.A.) $7.00

Published by the British Medical Association, London, England
Send orders to Grune and Stratton, Inc., 381 Fourth Ave., New York 16, N.Y.

BOOK REVIEWS

THE CONTAX WAY, H. Freytag, Focal Press, Ltd., London, 271 pages, illustrated, (1953), bound, $3.75. (Available at all Zeiss Ikon authorized dealers.)

Mr. Freytag is widely known on the European Continent for his versatility and adeptness in the use of miniature cameras. He has had many years of experience with *Contax* cameras, thus, is well equipped to write about them. His experience has not been limited to general photography, as evidenced by the material that he includes in his book on scientific, medical and industrial photography. *The Contax Way* was originally written in German, but the present edition is an English translation that brings Mr. Freytag's wealth of practical information before a much wider audience.

MENTAL HEALTH MOTION PICTURES, U.S. Government Publication, Catalog No. FS 2.22:M 85/4, Superintendent of Documents, Washington 25, D.C., 124 pages (1952), paper bound, $0.30.

This list of mental health films has been compiled to bring to the attention of those who are interested in mental health information the available films that have been reviewed by members of the Health Institute staff. It is not presented as a comprehensive catalog of all mental health films.

MOTION PICTURES ON CHILD LIFE — A LIST OF 16mm FILMS, U.S. Government Publication, Catalog No. FS 3.202:M 85/2, Superintendent of Documents, Washington 25, D.C., 60 pages, (1952), $0.40.

Parent groups in particular will be interested in this compilation of data on available child life films. Covering such subjects as adolescence, child care, development, health, and many others, the list shows the titles of films, running time, sound or silent, color or black and white, where they can be obtained, and whether charges are made for the films' use.

INFRARED PHOTOGRAPHY IN MEDICINE, Leo C. Massopust, Sr., American Lectures in Medical Photography, edited by Ralph P. Creer, Charles C. Thomas, Publishers, Springfield, Ill., 53 pages (1952), 5¾ in. x 8¾ in., flexible binding, $2.75.

The author of this book is well known to Association members, both as a previous editor of JBPA and as a specialist in the application of infrared photography in medicine. It is apparent that Mr. Massopust has prepared this latest work on infrared photography to appeal to the practicing medical doctor who has had little background in the field. The book is far from comprehensive. It is well illustrated and written in a simple style for the non-specialist. A bibliography of 45 references is given for those who wish to pursue the subject further.

LIBRARY CATALOGUE, Supplement to the 1939 Author Catalogue, 41 pages (1952), 2 shillings 6 pence, and LIBRARY CATALOGUE, Part 2, According to Subject, 105 pages (1952), 5 shillings, Royal Photographic Society of Great Britain, 16 Princes Gate, London, S.W. 7, both 7⅛ in. x 9½ in., paper bound.

The first catalogue of the Library of the Royal Photographic Society was published in 1893. It was a small volume of 36 pages. The second catalogue, dated 1907, contained 193 pages, consisting of an authors listing, a subject listing, and a periodicals listing, arranged in chronological order. The Library of the R.P.S. continued to grow at such a rapid rate that it was necessary to publish a separate periodicals catalogue in the Society's journal in 1936. An Authors Catalogue of the books contained in the library appeared in 1939 through the generosity of the late Mr. Edward Epstean. The present publications bring these previous Author and Subject Catalogues up to date.

To anyone interested in the literature of photography these catalogues are invaluable.

COMPARATIVE EMBRYOLOGY OF THE VERTEBRATES, Olin E. Nelson, The Blakiston Company, Inc., Philadelphia, 982 pages (1953) illustrated, cloth bound, $8.00.

This comprehensive textbook is divided into sections on the period of preparation, of fertilization, the development of primitive embryonic form, histogenesis and morphogenesis of the organ systems, and on the care of the developing embryo. Comparative anatomy is correlated with comparative embryology making the book useful reading for the biological photographer working in these fields. The many drawings are clearly reproduced, but the photographs do not come out as clearly. The book appears to be reproduced by a gravure-like process and is an example of how biological photographs have to be prepared for this kind of reproduction. (O.W.R.)

PLANT ANATOMY, Katherine Esau, John Wiley & Sons, Inc., New York, N.Y., 735 pages (1953), illustrated, cloth bound, $9.00.

Biological photographers specializing in botany will find this comprehensive treatment of the structure of the seed plants useful background material. Detailed reference lists are given. The plates contain some good photomicrographs and might be examined to show the kind of biological illustrations needed for textbooks and scientific articles in this branch of science. (O.W.R.)

METHODS FOR MEDICAL LABORATORY TECHNICIANS, U.S. Government Publication, Catalog No. D 101.11:8-227, Superintendent of Documents, Washington 25, D.C., 746 pages (1951), illustrated, paper bound, $2.50.

Here is another of the Army's excellent training manuals which serves its purpose outside the military establishments as well as within. Wherever medical laboratory technicians are trained, this manual will be useful. It covers in detail basic laboratory procedures, blood examinations, general chemical technique, general bacteriologic methods, protozoological methods, and many other laboratory techniques too numerous to mention here. Student technicians, in particular, will be able to use this manual to advantage, and other medical students and instructors will find it helpful.

SYMPOSIUM ON MEDICAL WRITING, American Medical Writers' Association, 209-224 W.C.U. Bldg., Quincy, Ill., 24 pages (1952), unbound reprint, free upon request.

At the St. Louis annual meeting of the *American Medical Writers' Association* (Oct. 1952) a number of papers were presented covering many phases of medical writing. These papers appeared in the January number of the *Mississippi Valley Medical Journal* for January, 1953. A collective reprint of all these papers has been made available by the A.M.W.A., and may be obtained from Harold Swanberg, M.D., Secretary, at the address given in the above heading.

The titles of the papers are as follows: *Things Medical Writers Shouldn't Do*, Walter C. Alvarez, M.D.; *Why Write?*, J. Linwood Cutler, M.A.; *Editing the Medical Manuscript*, Theodore Peterson, M.S.; *Medical Writing and a Medical Manuscript Editing Service*, Harold Swanberg, M.D.; *Wanted More Medical Writers*, W. W. Bauer, M.D.

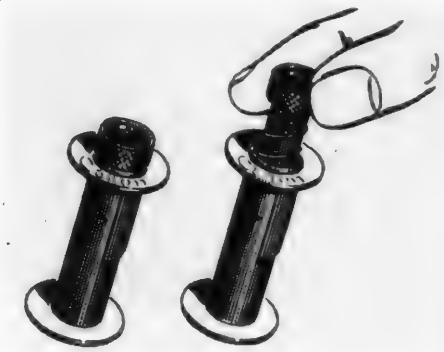
HANDBOOK OF BASIC MICROTECHNIQUE, Peter Gray, Ph.D., D.I.C., The Blakiston Company, Inc., Philadelphia, 141 pages, illustrated, (1952), 6¼ in. x. 9¼ in., cloth bound, $3.00.

In addition to a preface and index this volume consists of two main parts. The first part consists of nine chapters pertaining to the materials and processes of slide making, and the second part consists of fifteen specific examples of slide making. The book appears to be exceptionally practical, and is based on actual laboratory experience of the author. The author includes suggestions for the adaptation of his techniques to specific organisms from the standpoint of their cytological, histological, anatomical and morphological structures.

STYLE MANUAL FOR GUIDANCE IN THE PREPARATION OF PAPERS FOR JOURNALS, American Institute of Physics, 57 E. 55 St., New York, N.Y., paper bound, $1.00.

Many style manuals have been published, but few have been directed to scientific writings. In this manual a review is presented of a paper's history, with sections on preparing and styling manuscripts, figures for illustrations, mathematical expressions, etc. Valuable lists of available special characters and signs are also given.

New Products



SPECIAL TAKE-UP SPOOL

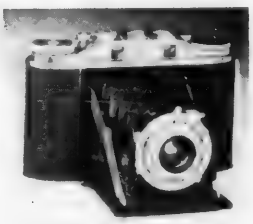
A special feature of the Canon IV-S2 camera which has been very enthusiastically received, according to the distributors, is the take-up spool. It is provided with a spring-loaded grip which is released with a slight turn of the spool core so that it extends out of the camera, facilitating easy removal. The removal of conventional take-up spools from similar cameras involves some inconvenience. It is awkward to attempt to reach into the camera and to grasp the grip with thumb and forefinger. This Canon take-up spool has been standard equipment with the Canon IV-S2 camera, but is now available as a separate accessory. List price, $2.15. Further information can be obtained from Balfour, Guthrie & Co., Limited, 67 Wall St., New York 5, N.Y.

NEW CONTAX TELEPHOTO LENS

A new 85mm, f/4 telephoto lens, the Zeiss Triotar, is now available for use on Zeiss Ikon Contax IIa and IIIa cameras. The lens consists of three coated elements, with six air-to-glass surfaces. It is claimed that the lens is highly corrected.

The Triotar is not intended to replace the well-known Sonnar 85mm, f/2 lens. Rather, it is supplied as a comparatively inexpensive lens for general use where the slower f/4 maximum relative aperture suffices. The lens will accommodate the standard 42mm slip-on Zeiss Ikon filters, as well as the special lens shade made for the Sonnar 85mm lens. List price from all authorized Zeiss Ikon dealers, $139.00.

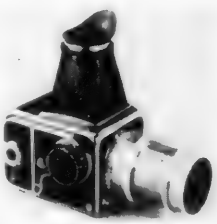
TWO NEW ANSCO CAMERAS



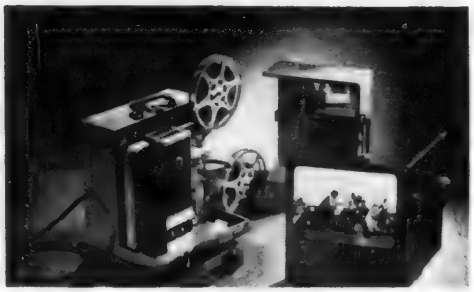
A new 35mm camera, the Ansco Regent, and a new 120 roll film folding camera, the Ansco Speedex Special "R", have just been announced. Both cameras are in the medium price bracket. The Speedex Special "R" (see illustration) has a built-in uncoupled rangefinder. Focusing of the independently operated finder is accomplished through the combined rangefinder-viewfinder window. The lens is then set manually according to indicated distance reading, assuring sharply focused images without the cost of lens coupling. In overall design, the camera is much like the earlier Speedex cameras. It has an f/4.5 Apotar coated, anastigmat lens, a built-in self-timer and a double-exposure prevention device. It takes 2¼ in. x 2¼ in. pictures on 120 size film. List price, $57.50, including tax.

The Ansco Regent Camera is a low priced 35mm miniature, priced at $54.50. It has a coated f/3.5 Agfa Apotar anastigmat lens in a flash synchronized shutter giving speeds up to 1/300th second.

HASSELBLAD MAGNIFYING HOOD



A new magnifying hood for the Swedish Hasselblad reflex camera is now available. This accessory permits focusing in brilliant light by shutting out all extraneous light. It contains a coated 2½ power critical focusing device for help in close-up work. The full area of the ground glass is covered, thus, no picture essentials are eliminated from the field of view. It is made in one piece and slides in to replace the standard focusing hood of the Hasselblad camera. List price $34.00. For further information write to Willoughbys, 110 W. 32nd St., New York 1, N.Y.



NEW KODAK PROJECTOR FOR 16MM FILM STUDY

The Kodascope Analyst Projector, a 16mm silent projector, is intended for those who wish to study 16mm movies closely. The projector has been undergoing engineering development for several years. It is designed for those who need to reverse the direction of films frequently during projection and detail study to evaluate action and continuity.

The projector features a constant-speed blower motor which provides continuous cooling of the projection lamp regardless of the running speed of the projector or direction of film travel. It also has a two-speed governor-controlled second motor that independently drives the film-moving mechanism. This dual motor arrangement permits the mechanism to give almost instantaneous starts and reverses.

Other features include a newly developed reflecting coating on the condenser lens and a superior type of heat-absorbing glass which makes a safety shutter unnecessary. This design eliminates blanking out of the picture when the film is reversed, and permits an analysis of motion which cannot be obtained in any other way.

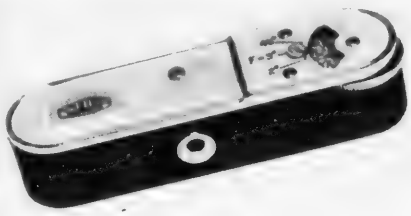
Another unique feature of the projector is a Daylight Projection Viewer which is carried in the projector case. This includes a special front surfaced mirror that reflects the projected image onto a rear view screen located in front of the operator.

The Kodascope Analyst Projector has 400-feet film capacity, and operates on 105-125 volt, 60-cycle A.C. power lines. Its overall dimensions are 12½ in. x 14¼ in. x 10¾ in. It lists at $295. For further information, write Cine Kodak Sales Division, Eastman Kodak Company, Rochester 4, N.Y.

SOUND TRANSFER FACILITIES FOR RE-RECORDING

J. A. Maurer, Inc., manufacturers of professional 16mm sound motion picture equipment, and Precision Film Laboratories, 21 W. 46th St., New York, have combined their specialized experiences to offer a new sound transfer service for producers and users of motion picture films and tape recordings.

The service includes complete facilities for transferring sound records in almost any form, to and from any two types of recording medium. Emphasis is being placed on the quality transfer of sound from practically any form of magnetic or disc recording to a film optical track (either 16mm or 35mm). The well-known Maurer 6-channel 16mm variable area track is employed for re-recording. For full data and prices write Precision Film Laboratories.



PULLIN RANGEFINDER

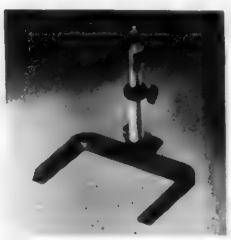
The new Pullin Rangefinder incorporates a swing-wedge principle and new optical system. Focusing is effected by the swing of a convex lens in a "swing-wedge" assembly. The rotation necessary to secure coincidence is indicated on a calibrated dial which shows the distance range. Accuracy is said to be insured because the movement of the swing-wedge is four times greater than that of a rotating mirror for the same distance measurement. The complete instrument weighs less than 3 oz. and measures only 4 in. x 1 in. x 1 in. It measures distance down to 2 feet, enabling modern wide-aperture lenses to be used for close-ups with the more certainty of correct focusing. For further information, write Camera Specialty Company, 50 West 29th St., New York, N.Y.

NEW ACCESSORIES FOR KODAK RETINA CAMERA

Five new accessories for Kodak Retina Cameras have been announced by the Eastman Kodak Company. The accessories include a Kodak Retina Sports Finder for fast action photography, and four accessories for use in close-up photography the Kodak Retina Close Range and View Finder, the Kodak Table Top Camera Stand for use with Kodak Retina and other cameras, the Kodak Retina Close-Up Kit, and the Kodak Retina Camera Platform.

The Kodak Retina Sports Finder is an open-frame accessory finder. It fits in the accessory clip on top of the cameras, and has parallax adjustment to correct for camera-to-subject distances from 3½ feet to infinity. It is collapsible, and comes with a leather carrying case for picture takers who do not wish to keep it mounted on their camera. It will fit both Kodak Retina and Retinette Cameras. List price $6.50.

The Kodak Retina Close Range View Finder is a combined superimposed-image type range finder, parallax-correcting finder, and three close-up supplementary lenses, enclosed in a leather case. It will aid in obtaining greater accuracy in true close-up photography where camera alignment and focus are often difficult. The Close Range and View Finder fits the accessory clip on top of the Kodak Retina II and IIa Cameras. The supplementary lenses screw into the front of the camera lens. The adjusting dial on the Finder has three separate scales which indicate the proper supplementary lens to be used and the correct camera focus scale setting for a given lens-to-subject distance. The supplementary lenses permit picture taking at distances as close as 8¾ inches. List price $48.00.



The Kodak Table Camera Stand consists of an adjustable post mounted on a sturdy U-shaped base with a two-section telescoping upright, and a ball-and-socket swivel head. With this base, Kodak Retina and Retinette Cameras can be tilted from straight up to straight down. Stand height may be adjusted up to 12 inches. The ball-and-socket head may be removed from the telescoping upright and used on other tripods when desired. All tripod sockets and threads conform to A.S.A. Standards, and the stand can therefore be easily used with most American-made cameras. List price $29.50.

The Kodak Retina Camera Platform is designed for use with the Kodak Retina Close-Up Kit and the Kodak Top Camera Stand, or with other types of tripods with swivel tops. It permits Kodak Retina and Retinette Cameras to be centered over the tripod screw swivel top so that they can be swung on their axis as desired. List price $5.25.

BERTHIOT 1 inch — f/1.9 LENS

Camera Specialty Company, 50 West 29th St., New York 1, N.Y. have announced the availability of the Berthiot 1 inch, f/1.9 lens, with Clickstops. It is adaptable to all 16mm cameras with a standard "C" mount, e.g., the Bolex, Victor, Keystone, Bell & Howell Camera, etc. The lens has a focusing mount with a range from 2½ ft. to infinity. Diaphragm stops are from f/1.9 to f/16. List price $36.50.

IMPROVED VARIGAM FILTERS

New plastic filters of suitable optical quality for use in front of enlarger lenses in exposing Du Pont "Varigam" variable contrast paper are now available in retail stores. The plastic filters are expected to supersede the lacquer-protected gelatin filters currently in use. In addition to being flat and of good optical clarity, the new filters are claimed to be durable, and to have surfaces highly resistant to scratching and to moisture. They are reported to have excellent color stability.

Mounted plastic filters are supplied in one size only, consisting of a black plastic frame 2½ inches square with a 2⅛ inch circular filter aperture. Sets of five or ten filters are packaged in a blue and yellow plastic box which serves as a storage file for the filters. A molded black plastic filter holder, which fastens to the enlarger lens barrel, is also available. Included with each set is a filter selection chart.

Plastic "Varigam" filters in unmounted sheet form, for use in enlargers between the light source and negative and in contact printing, are available on special order.

Your Association

● *A section of the Journal devoted to official announcements, chapter news, activities of members, and other such matters concerning the Association.*

PRELIMINARY REPORT ON FORTHCOMING 23rd ANNUAL MEETING

Mr. William L. M. Martinsen, General Chairman, has submitted a preliminary, although incomplete, program for the 23rd Annual Meeting of B.P.A. to be held at the Statler Hotel, Los Angeles, California, August 31 to September 3, 1953. (Mr. Lloyd Matlovsky, Room 2653, 1200 North State St., Los Angeles, is Chairman of the Program Committee.)

August 31: Registration, opening addresses and two papers.

For lunch members will be the guests of the Walt Disney Studios. Luncheon will be served in the Studios' cafeteria, following which a programs session will be held in one of the Disney amphitheaters. At this session an antimated film on blood cells will be shown entitled "Defense Against Invasion". A 70-minute preview of a new Disney science film on desert life will be shown. Lectures by staff members of Disney Studios on antimation and science film production are also scheduled.

An evening session is planned for color slide projection.

September 1: The entire program on this day will concern motion picture technology. There will be papers on magnetic sound, television shooting and cutting, high speed medical motion picture techniques, radiographic motion pictures, etc.

Motion pictures will be projected in the evening.

September 2: Still photography will be the feature subject, including papers on still camera techniques, color duplicating, oscilloscope recording, stereo photography, and a symposium on speed light equipment and applications.

An open house at which the general public will be invited is scheduled for the evening.

September 3: The program during the day will consist of a series of papers on photomicrography and the applications of photography as a research tool.

In the evening the Kodak Cocktail Hour will precede the Annual Awards Banquet.

For those who wish to stay on after the conclusion of the regular program, several interesting field trips are being planned. These include trips to the Huntington Library, California Institute of Technology, Mt. Wilson Observatory, and the Moody Institute of Science.

A special program for wives of members and guests is also being arranged to keep them entertained during the formal program sessions. A tour of the world-famous Farmers' Market, including a tea, has been arranged. Shops along Wilshire Blvd., known as "Fabulous Boulevard" will be visited, and several radio and TV programs are on the schedule. It is hoped, too, that a special trip to one of the major motion picture studios can be included on the Ladies' Program.

Special Notice

Members in the East Coast states will be glad to know that Warren Sturgis is making arrangements with a reliable New York travel agency to handle reservations, either plane or train, for those who plan to attend the 23rd Annual Meeting in Los Angeles. Full details will be given in the Spring Mailing. It is quite possible that many members can travel together in a special Pullman car or in a chartered plane.

CHAPTER NEWS

Warren Sturgis, Chairman, Chapters Committee

Boston: January 27, at Harvard School of Dental Medicine, a discussion was held on the use of photography and X-ray in the Art Museum. Showing of film, "Is Your Van Meer Authentic?"

Chicago: February 17, at St. Luke's Hospital, a "Gadget Night", with Wolfgang Zieler as moderator; a paper on "Copying of X-Rays", by Charles Lindsay; and one on "A Clinical Report on Magnetic Sound", by Maria Ikenberg.

New York: February 26, "Clinical Photography", a paper covering backgrounds, lighting, and film stock, by Barbara Turkington; and "Equipment in Medical Photography", by Nathan Kantor. March 26, "The Theory, Technique, and Application of Radioautography", by Jerry Weinstein; and "The Importance of Photography in the Application of Electron Microscopy in Biology and Medicine", by Clifford E. Grey. Both speakers are on the staff of the Sloan-Kettering Institute for Cancer Research. April 23, The Fourth Annual Photographic Salon of the chapter was held at Cornell University Medical College.

Northern Ohio: January 7, at Merrill David Color Studios, business meeting, followed by an informative talk by Mr. David, in which he discussed Ektachrome processing, dye transfer prints from Ektachrome transparencies, copying of paintings, and multiple flash exposure calculation. February 4, at Crile Veterans Hospital, a general meeting on print quality, and the functions of the B.P.A., led by David Lubin. March 4, at Cleveland City Hospital, "The Repair of Cameras and Synchronization of Shutters", a topic presented by Mr. R. Krumhansl.

Rochester: February 17, "Problems in Medical Photography", a paper by Stella Zimmer of the Medical Center at Syracuse University; and two motion pictures, "India Ink Injection of Beef Heart" and "Intravascular Agglutination of Red Cells in Hamster Cheek Pouches". March 17, "Photographic Evaluation of Deformity", by John Gaughan; and a second paper, "Problems in Undersea Photography", by Prof. John F. Storr of Cornell University.

MID-SOUTH CHAPTER ORGANIZED

We should like to welcome into the fold the newly formed Mid-South Chapter of B.P.A., which held its organization meeting on April 3 at the Kennedy V.A. Hospital, Memphis, Tenn., under the leadership of Mr. Alex A. Gravesen. Mr. Gravesen was elected Chairman of the 15 member group on April 24. The group's application for a chapter charter was approved by the national B.P.A. board in May. Mr. Jack Fletcher was elected Vice-Chairman, and Miss Mary J. McKnight, Secretary-Treasurer, Box 99, Kennedy V.A. Hospital, Memphis 15, Tenn.

Anyone within a 400 mile radius of Memphis who is eligible for B.P.A. membership may join the chapter.

Southern California: February 19, at Los Angeles County Museum, two papers, "Measurement of Light", by Frank Crandall, of the California Institute of Technology; and "Artificial Light Sources for Photography", by Earl Auld, of General Electric Company. March 19, following a "meeting for dinner at Carl's Restaurant — where vital questions bothering us all are discussed" again two papers, "Small Versatile Duplicating Rig for Stills and Close-Ups", by Lloyd Matlovsky, and "Photography of Fungus Plates and Bottles in Color", by Avis Gregersen. April 16, chapter members enjoyed a "Tour of the Los Angeles Scientific Crime Investigation Laboratory". (More complete report on this later.)

REPRODUCTION OF THE PICTURE-OF-THE-MONTH AWARD GIVEN BY THE NORTHERN OHIO CHAPTER

LEONARD JULIN ANNUAL AWARD PRESENTATION *

Ralph P. Creer, FBPA

AS the most recent recipient of the B.P.A. Annual Award, it is my honor and privilege to present the 1952 award to an outstanding member of the Association.

For a period of almost 25 years, this member has successfully directed one of the largest and most active clinical photographic departments of the world. He was a pioneer in the production of 16mm surgical motion pictures. During the past 20 years, he has made a series of more than 1,000 surgical films, most of which have been accepted for exhibition at national medical meetings in this country and abroad. During World War II, the Armed Forces used these films extensively as an effective method of post-graduate training.

He has developed new technics and equipment which have improved the technical quality of clinical photographic illustrations. Of special value to the medical profession is the development of a semi-automatic aseptic surgical camera. He has always maintained the highest standards of craftsmanship, character and integrity.

He is a Charter Member of the Biological Photographic Association and was its third president from 1940 to 1942. Serving on numerous important committees during its formative years, he played an active role in guiding the destiny of our Association. We have leaned heavily upon his sound judgment.

For his outstanding contributions to the progress of biological and medical photography and for his valued services to the Biological Photographic Association, the Board of Directors is proud to name as the recipient of the 1952 Annual Award, Leonard Julin, FBPA, Director, Section of Photography, Mayo Clinic, Rochester, Minnesota.

ACTIVITIES OF MEMBERS

Burton C. Staugaard has just informed us that he has resigned from his position as Director of the Photographic Department at Rhode Island Hospital to do graduate work in zoology at the University of Rhode Island.

Fritz Goro returned not so long ago from an interesting trip in the Bahamas where, on an assignment for Life, he made aerial photographs of the island's coastline, swamps, golfstream movements, etc. He also spent two months at the Lerner Laboratory of the American Museum of Natural History, located on Bimini Island, making color photographs of marine life. Mr. Goro also braved the ocean depths to do some underwater photography at Nassau.

Joseph D. Brubaker reports that he has done extensive research and redesigning for some new models of endoscopic equipment for still and motion picture purposes. The new designs are described as being considerably more versatile than his previous equipment. A separate coaxial endoscopic illuminator for use with still and motion picture cameras has also been designed. Mr. James E. Brubaker, Waukegan, Ill. will manufacture these new equipment items.

Carl M. Bishop made the illustrations for the new pathology book entitled "Reaction to Injury", Vol. II, by Dr. W. D. Forhus, Williams & Wilkins Publishers, 1952.

* Presented at the Annual Banquet, 22nd Annual Meeting, N.Y.C., 1952.

Dr. Oscar W. Richards, FBPA, presented a paper on "Night Vision" before the Southwestern Connecticut Section of the Optical Society of America on April 16, 1953.

A paper by Melvin Siegel entitled "Photography in the Textile Industry" appeared in the December 1952 number of the PSA Journal, Section B, Photographic Science & Technique.

Robert W. Pennak advises that a new book by him will appear on April 15. It is entitled "Fresh Water Invertebrates of the United States". It will have 780 pages, with 470 line and photographic illustrations. The Ronald Press, New York City, is the publisher.

H. Lou Gibson, FBPA, is completing a book on medical copying and duplicating for Charles C. Thomas, Publishers. The book is due to appear in 1953.

Miss Ann G. Pass is now associated with Miss Stella Zimmer, FBPA, at the New York State University Medical Center in Syracuse. These "gals" really stick together.

Ruth Maxwell Sanders has prepared a paper for the Texas Journal of Science entitled "The Preparation of Scientific Graphs". We were not advised which number will contain her paper.

Thomas T. Hill has been appointed Consultant to Chemistry Division, Air Research and Development Command, Baltimore, Md.

Willard C. Shepard is co-author of the new book entitled "R/x for Medical Writing" by Jordan & Shepard, W. B. Saunders Co., Philadelphia.

Avis Gregersen, FBPA, is in the midst of a large undertaking involving numerous color photographs of fungi.

Frederick W. Maynard had an interesting series of photographs on the hamster cheek pouch in Pfizer's "Spectrum" which appeared in the October 11, 1952 number of J.A.M.A.

Jerry Weinstein reports that a new publication of his entitled "The Theory, Technic and Applications of Radioautography" is now in press.

Deam H. Ferris reports that he has taken a leave of absence from Graceland College, where he was instructor in biology, to take work toward a Ph.D. at the University of Wisconsin. He has a research assistanceship in the Department of Veterinary Science, and is in charge of photographic and audio-visual work, and is Chairman of this department's Photographic and Audio-Visual Committee. His research task concerns the transmission of virus diseases by insects.

Lloyd E. Varden, Journal Editor, was Chairman of the Symposium on Photographic Instrumentation held April 11, 1953 at Columbia University, New York City. The Symposium was jointly sponsored by Columbia University School of Engineering, and the New York Chapter of the Society of Photographic Engineers. Papers were presented on equipment for underwater photography, oscillographic recording, nuclear emulsion techniques, photographic instrumentation in nuclear studies, the application of photography in determining ion exchange rate and progress in high-speed photographic instrumentation.

On Kent H. Wilson's membership dues form under the heading "New Work Undertaken in 1952" is stated "Joined the U.S. Air Force!"

Please Keep the Editor Informed of Your Activities

OBITUARY

Mr. Kenneth Shaftan, New York City, was killed in a plane crash on April 4, 1953. He was 34 years of age. He had been a B.P.A. member since 1949, and an enthusiastic supporter of the Association's activities and purposes. Mr. Shaftan was a Commander in the U.S. Naval Reserve and Director of Photographic Instrumentation, J. A. Maurer, Inc., Long Island City, New York. He was a consultant in photographic instrumentation to the Office of Naval Research and a consultant on the Panel of Photography and Optics, Department of Defense, Research and Development Board. At the time of the tragic accident, Mr. Shaftan was returning from a special military mission in Texas with two other engineers, who were also killed.

Mr. Shaftan was the President of the New York Chapter, Society of Photographic Engineers, and Chairman for this society's 1953 Annual Conference to be held May 20-22 at West Point, New York. He was also an Active Member in the Society of Motion Picture and Television Engineers in whose journal many of his papers had been published. He was a member of the American Physical Society, the Optical Society of America, and the Royal Photographic Society of Great Britain.

Mr. Shaftan graduated with the degree of Bachelor of Chemical Engineering from New York University. In addition, he had taken work at Columbia University and George Washington University. He was buried at the Arlington National Cemetery on Wednesday, April 8.

NEW B.P.A. MEMBERS

(Jan. 1953 through Mar. 1953)

Fernando Gonzales Abete, *Havana, Cuba*
Newell H. Battles, M.D., *Idaho Falls, Idaho*
Harold J. Bowen, *Little Rock, Ark.*
Lytton W. Boyle, *Experiment, Ga.*
Bernard D. Briggs, M.D., *Stoneham, Mass.*
Douglas A. Caywood, *Camp Gordon, Ga.*
LeRoy P. Christenson, *Minneapolis, Minn.*
Wilfred A. Cote, Jr., *Syracuse, N.Y.*
Sylvia S. Covet, *Minneapolis, Minn.*
Sam Drucker, *Winnetka, Ill.*
Catherine Anne Geffken, *Atlanta, Ga.*
Irving I. Goodof, M.D., *Waterville, Me.*
Preston F. Gott, *Lubbock, Tex.*
Robert S. Harper, Jr., *Albuquerque, N.M.*
Dr. Herbert H. Holliger, *Huron, Ohio*
Harry Jeffries, *Cleveland, Ohio*
Bert M. Johnson, *Ann Arbor, Mich.*
V. M. Jordan, M.D., *Cleveland Heights, Ohio*
William B. Kubey, *Cleveland, Ohio*
Julius E. Lohn, *Chicago, Ill.*
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Mrs. J. W. MacQueen, *Birmingham, Ala.*
James L. Markland, *Chicago, Ill.*
Daniel A. McCann, *Brooklyn, N.Y.*
Dr. K. A. McMurchy, *Edmonton, Canada*
Frank P. McWhorter, *Corvallis, Ore.*
Robert M. Moore, Jr., *Yeadon, Pa.*
Foster E. Moyer, *West Lawn, Pa.*
Ralph A. Parker, M.D., *Franconia, N.H.*
Wallace Patterson, *Chapel Hill, N.C.*
A. W. Rakosy, *Chicago, Ill.*
David Allan Ringle, *Yonkers, N.Y.*
C. J. E. Robinson, *New York, N.Y.*
Robert A. Sawin, *Marblehead, Mass.*
Hans F. Schoenfeld, *Toronto, Canada*
Benjamin V. Siegel, *San Francisco, Calif.*
Robert C. Simpson, *Vincennes, Ind.*
John C. Sinclair, *Los Angeles, Calif.*
Walter P. Stewart, *Norwood Grove, Man., Canada*
Atlee S. Tracy, *Lemont, Ill.*
Dr. Lewis B. Udis, *Philadelphia, Pa.*
Dr. Evelio Villar, *Havana, Cuba*
William D. Wallace, c/o *Postmaster, New York, N.Y.*
John Whitfield, *Dhahran, Saudi Arabia*
James D. Wimpee, M.D., *Detroit, Mich.*

For Information Concerning Membership in the Biological Photographic Association, Write the Administrative Secretary, 533 W. 57th Street, New York 19, N. Y.

REPORT OF NOMINATING COMMITTEE

The Nominating Committee, consisting of Mr. Leonard A. Julin, FBPA, Chairman, Dr. Oscar W. Richards, FBPA and Dr. Edmond J. Farris, FBPA, have submitted the following slate of nominees for 1954.

PRESIDENT	WARREN STURGIS
VICE PRESIDENT	H. LOU GIBSON
SECRETARY	JANE H. WATERS
TREASURER	ALBERT LEVIN
DIRECTORS	HARRY E. MORTON MERVIN LARUE

The election ballot will be sent to all members as a part of the usual Spring Annual Meeting announcement, scheduled for mailing approximately June 15.

In keeping with Article VI of the B.P.A. Constitution and By-Laws, any nominee proposed for an office by a petition of at least ten active members will be added to the official ballot.

CONCERNING LETTERS TO THE EDITOR

Your editor has received from several members the suggestion that a "letters to the editor" page be established in the Journal. The suggestion was received with alacrity. There is nothing that would be more stimulating for overall reader interest than to publish constructive letters about the Journal and its contents.

The only rub is that your editor has been unsuccessful in obtaining such letters, even though in a few instances they were promised. But you can rest assured that suitable letters will find their way into the Journal if they are received.

THIS NUMBER OF THE JOURNAL

Members will no doubt wonder if the size of this number of the Journal represents a permanent change. The Journal normally consists of 48 pages and cover, but this number has 64 text pages. The increase in size was brought about by the longer than usual length of two papers, neither of which were very adaptable to publishing in two parts.

It would be desirable to have a 64 page journal each number, but the present budget will not permit it. Your editor is hopeful that the number of subscribers will increase sufficiently within the next year to enable the Association to have a larger and more attractive publication.

NEW BOSTON CHAPTER SECRETARY

In Volume 21, No. 1 (February, 1953) the names and addresses of all chapter secretaries were published. The Boston Chapter held an election of officers early this year, and now has a new secretary, Miss Barbara Jacobs (Peter Bent Brigham Hospital). Address, 72 Egmont Street, Brookline 46, Mass.

THE AMERICAN BIOLOGY TEACHER SEEKS PHOTOGRAPHS

The Managing Editor of The American Biology Teacher, Mrs. Muriel Beuschlein, is in need of suitable photographs to be used for forthcoming cover illustrations of A.B.T. BPA members especially are invited to submit photographs for this purpose. If you have anything of a biological nature that you think would be suitable, contact Mrs. Breuschlein, 6431 S. Richmond, Chicago 29, Illinois.

MICROTOME FOR SALE OR EXCHANGE

B.P.A. member Mr. J. W. Morris, 415 Goode St., Houma, La., wishes to sell or exchange a used Spencer completely enclosed rotary microtome, in new condition. In exchange he desires a Hasselblad reflex camera. For further information write directly to Mr. Morris.

CONTRIBUTING MEMBERS

Alexis A. Alvey
Anonymous
J. Mason Baird, M.D.
Harold C. Baitz
A. V. Banones
Earl C. Bartlett
Edna Campbell Barker
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FELLOWSHIP PROCEDURE

Members may propose for Fellowship in the BPA other members whom they consider worthy of recognition. To be eligible for Fellowship a candidate must have been a member of the Association for five consecutive years and must possess one or more of the following qualifications:

Superior craftsmanship in still or motion picture photography of biological subjects.
Ability in photographic research in new methods or materials.

(These require submission of evidence.)

Meritorious contributions to biological photography overall through sustained organizational work.

Two sponsors are required. The sponsors should be well acquainted with the candidate's work and should be ready to furnish the Board with details of his experience and achievements. Those who wish to sponsor a member whom they believe to be eligible should request a Fellowship Application form from the Secretary of the Fellowship Committee: Miss Anne Shiras, Photographic Department, Magee Hospital, Pittsburgh 13, Pennsylvania.

CONTENTS

JOURNAL OF THE BIOLOGICAL PHOTOGRAPHIC ASSOCIATION

Volume 21, Number 2 — May, 1953

DESCRIPTION OF A CAMERA ILLUMINANT UNIT EMPLOYING VERTICAL ILLUMINATION . . . . . Charles Hale 1

EXPOSURE EVALUATION FROM PHOTOMETER MEASUREMENTS IN MULTIPLE LENS SYSTEM PHOTOGRAPHY . . . . . Julius Weber and Gershon Shapira 11

THE KODAK EKTALITH PROCESS 34

PHOTOGRAPHIC GUNS . . . . . Jean Dragesco 39

INCREASING THE SPEED OF COLOR FILM FOR HIGH-SPEED FLASH PHOTOGRAPHY OF THE OCULAR FUNDUS . Lardner A. Coffey 42

RAPID EXPOSURES IN COLOR PHOTOMICROGRAPHY . Joseph E. Mineo 45

HIGH CONTRAST COLOR PHOTOMICROGRAPHY . William E. Perry 47

THE PHOTOGRAPHIC SOCIETY OF AMERICA . . . . Don Bennett 49

BIOLOGICAL PHOTOGRAPHIC ASSOCIATION AND ITS JOURNAL . . Leonard A. Julin 50

CONTENTS OF MEDICAL AND BIOLOGICAL ILLUSTRATION 52

BOOK REVIEWS . . . . . All reviews by the Editor except those noted by Oscar W. Richards 53

NEW PRODUCTS 55

YOUR ASSOCIATION 58

CONTRIBUTING MEMBERS 64

SUSTAINING MEMBERS, FELLOWS OF THE ASSOCIATION, FELLOWSHIP PROCEDURE . . . . . Inside Back Cover

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